NUCLEAR SCIENCE ABSTRACTS

Volume 25 Number 14

Abstracts 31764-34499

July 31, 1971

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Volume 25, Number 14, July 31, 1971

NUCLEAR SCIENCE ABSTRACTS

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MEMBRANE FILTERS
design for removal of cell-free Streptococcus faecalus from bacteria cultures in fermentation tank, 23:49996 (UCRL-18667, pp 322-9)
MENDELEVIUM
separation from einsteinium and fermium by electrolysis, 23:49772 (UCRL-18667, pp 277-312)
separation from sodium acetate solutions by solvent extraction using sodium amalgam, 23:49772 (UCRL-18667, pp 277-312)
stability of divalent state of, 23:49772 (UCRL-18667, pp 277-312)

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Volume 25, Number 14 July 31, 1971

NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 31888, 31944, 32640, 32642, and 32661.

31764 (ANL/ST-6) INTERIM METHODS FOR THE ANALYSIS OF SODIUM AND COVER GAS. Burris, L.; Cafasso, F. A.; Meyer, R. J.; Barsky, M. H.; Edwards, H. S. (Argonne National Lab., Ill.). Jan 1971. Contract W-31-109-eng-38. 95p. Dep. NTIS.

A description is given of the following sampling and analytical procedures for use in USAEC-sponsored sodium-technology programs: (1) hydrogen, (2) carbon, (3) total oxygen, (4) oxygen activity, (5) nitrogen, (6) chloride and bromide, (7) trace metals, (8) gamma assay, (9) fission-product iodine, and (10) tritium in sodium; and (1) noble-gas radioisotopes, (2) hydrogen, (3) nitrogen, (4) carbon monoxide, (5) carbon dioxide, (6) methane, (7) tritium, and (8) oxygen in cover gas. (auth)

31765 PROCEEDINGS OF THE III. ANALYTICAL CHEMICAL CONFERENCE, BUDAPEST, AUGUST 24–29, 1970. VOLUME 1. SEPARATION METHODS. Buzas, I. (ed.). Budapest; Akademiai Kiado (1970). 318p. (CONF-700838-(Vol.1)).

Volume I of the conference proceedings includes 29 papers dealing with various aspects of separation processes applicable to analytical chemistry. Separate abstracts were prepared for 14 of these papers. (B.L.M.)

For abstracts of individual papers see: 31766–31771, 31810–31813, 31856–31858, and 31944.

31766 STUDY OF THE DISPLACEMENT CHROMATOGRAPHIC SEPARATION OF LANTHANIDES USING EDTA. Bruecher, E.; Szarvas, P. (L. Kossuth Univ., Debrecen, Hungary). pp 27-33 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

In displacement chromatographic separation of lanthanides, the effects of the rate of dissociation of complexes on the ion-exchange separation were studied using breakthrough curves. A column packed with Dowex 50 × 8 2/400-mesh resin in the Cu(II) or Er(III) form was converted to the Tb(III) form with ^{160}Tb-labeled TbEDTA solutions of various pH's. The gradient of the breakthrough curves decreased with increasing pH of the displacing TbEDTA solution with the extent of the decrease greater on columns in the Cu(II) form. The effects of pH and concentration of EDTA solutions on separations are discussed, and an equation is given for estimation of the value of the column height corresponding to one theoretical plate as a measure of the efficiency of the column. Twenty-one references are cited. (B.L.M.)

31767 EFFECT OF RESIN CROSS-LINKING AND OF TEMPERATURE ON THE SEPARATION OF ALKALINE EARTH ELEMENTS ON CATION EXCHANGE RESINS. Dybczynski, R. (Inst. of Nuclear Research, Warsaw). pp 35-43 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

The effects of various crosslinkings in the temperature range from 25 to 75°C on Dowex 50W sulfonic acid cation exchange resin separations of Ba, Ca, and Sr were investigated. Water uptake, ion exchange capacity, bed density, and particle size were determined for the resins of 2, 8, and 16 nominal cross-linkage and are tabulated. Mixtures of radioactive tracers, ^{45}Ca, ^{85}Sr, ^{89}Sr, ^{131}Ba, ^{133m}Ba, ^{135m}Ba, and ^{32}P were eluted from the three resins at various temperatures, and the elution curves for the alkaline earth elements from microcolumns are presented graphically. A formula is given for calculation of weight distribution coefficients from these curves. Resolution of the Ca–Sr pair increased monotonically with a rise in resin crosslinking in the temperature range studied; however, resolution for Ba–Sr showed a distinct maximum for medium crosslinking at room or moderate temperature. For simultaneous separation of Ba, Ca, and Sr, Dowex 50 W × 16 at 25°C was the best choice. (B.L.M.)

31768 BEHAVIOUR OF SOME LIGHT RARE EARTHS ON VARION CH COMPLEX FORMING ION-EXCHANGE RESINS. Balint-Ambro, I. (Research Inst. for Heavy Chemical Industries, Veszprem, Hungary). pp 45-50 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

The separation of rare earths was studied on four types of chelating resins with different functional groups on a polystyrene matrix. The results of the studies of the effects of pH on the partition properties of the different rare earths on the four different resins are tabulated. The chromatographic results confirm the bond strength order found by sorption equilibrium measurements and prove the applicability of complex forming ion-exchange resins to the separation of rare earths by varying the complex-forming ion-exchange group or the eluent to obtain various combinations to obtain the desired separation. (B.L.M.)

31769 SEPARATION OF CALCIUM AND STRONTIUM BY LIQUID ION EXCHANGE. Werner, G.; Hannig, R.; Dedek, W.; Holzapfel, H. (Karl-Marx Univ., Leipzig). pp 75-80 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

The separation of Ba, Ca, and Sr was studied using the liquid ion exchanger dinonylnaphthalenesulfonic acid (DNS) as the stationary phase, and the R_F values from various acids are tabulated. The reverse distribution order to that of nearly all other solvent extraction systems was noted as $D_{Ba} > D_{Sr} > D_{Ca}$. It is assumed that in the DNS extraction there is no complex formation, and the hydrated ions are carried into the organic phase so the ion with the smallest radius in the hydrated state (Ba) forms the most stable ion pair in the organic phase and is extracted better than Ca or Sr. Studies were made on enhancing the separation factor by complex formation in the aqueous phase using EDTA. In the pH range 5.0 to 5.5, using a multistage extractor, it was possible to separate Sr completely from Ca by extraction using DNA in heptane. (B.L.M.)

31770 EXTRACTION OF THORIUM WITH NEUTRAL ORGANOPHOSPHORIC COMPOUNDS IN THE PRESENCE OF AROMATIC CARBOXYLIC ACIDS. Jordanov, N. (Inst. of General and Inorganic Chemistry, Sofia); Mareva, St.; Nguyen Duc Thach. pp 159-

64 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838–(Vol.1).

The extraction of Th was briefly investigated using phosphorus compounds with different basicity of the phosphoryl oxygen atom in different solvents in the presence of some carboxylic acids, benzoic, salicylic, and cinnamic. A synergistic action was noted for the extraction in the presence of all three acids. Only the mechanisms of the extraction of Th with triocytylphosphine oxide (TOPO) in the presence of benzoic acid were studied in detail. Kinetic studies of the system indicated the formation of a mixed trinitrato-monobenzoato-Th(IV) complex that is easily solvated with TOPO molecules for extraction into the organic phase. From these kinetic studies and from knowledge of the distribution coefficients of U and rare earths under identical conditions, methods were developed for the determination of Th in rare earths and for the determination of Th and U in rocks. (B.L.M.)

31771 USE OF DI-2-ETHYL-HEXYL-PHOSPHORIC ACID SALTS AS STATIONARY PHASES IN GAS CHROMATOGRAPHY. Ilie, V. (Inst. of Chemical Researches, Bucharest); Oprea, M.; Baiulescu, G. E. pp 291-8 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838–(Vol.1).

The results of investigations on the behavior of some compounds of bis(2-ethylhexyl) phosphate with Li, Na, K, Th, Zr, U(VI), and $[Co(en)_3]^{3+}$ as stationary phases in gas chromatography in comparison with Apiezone L and the free phosphoric acid are reported. The relative retention volumes of various compounds at 125°C on the columns packed with the phosphoric acid compounds absorbed on Chromosorb W as referred to heptane are tabulated. Interaction between the various homologous series and the metal compounds was not noticeable for alkanes, aromatic hydrocarbons, and ketones. Strong interaction was noted between 2-pentanone and alcohols with the free acid column. For alcohols, the complexing action was noted to increase from tertiary to primary alcohols and to be more pronounced for Zr, Co, and Th compounds. (B.L.M.)

31772 PROCEEDINGS OF THE THIRD ANALYTICAL CHEMICAL CONFERENCE, BUDAPEST, AUGUST 24–29, 1970. VOLUME 2. ORGANIC ANALYSIS AND THERMAL ANALYSIS. Buzas, I. (ed.). Budapest; Akademiai Kiado (1970). 460p. (CONF-700838–(Vol.2)).

Volume II of the conference proceedings includes 63 papers on organic and thermal analysis. Separate abstracts were prepared for 2 papers. (B.L.M.)

For abstracts of individual papers see: 31814 and 31945.

31773 DETERMINATION OF RADIOACTIVE AND STABLE CESIUM. Abel, Emil; Mayer, Jan (Inst. of Hygiene, Bratislava). Chem. Listy; 65: 242-67(Mar 1971). (In Slovak).

The methods of isolation and determination of radioactive and stable cesium, mainly in the components of the environment, are reviewed. Papers published up to the middle of 1969 (251 papers) are included. For determination of radioactive cesium a combination of several radiochemical separation methods followed by gamma spectrometric measurements may be recommended as most suitable. Among the methods of determination of stable cesium, atomic absorption spectrometry and activation analysis are most sensitive. (auth)

31774 AIR POLLUTION. Mueller, Peter K.; Kothny, Evaldo L.; Pierce, Louis B.; (and others) (Dept. of Public Health and Air Resources Board, Berkeley, Calif.). Anal. Chem.; 43: No. 5, 1R-15R(Apr 1971).

Analytical activities concerning air pollution in 1969 and 1970 are surveyed with most of the papers cited dated in the period June 1968 to August 1970. The subject matter covered is divided into the broad classes of suspended particulate matter and gases. Sampling has received separate attention. Inorganic and organic pollutants are covered separately; however, within each of the sections methods have been separated with respect to air and source analyses. The field of automated air and source analysis and organoleptic and chemical testing of odors have all received separate treatment. Methods used in the analysis of biospecimens have also been covered. There are 557 references cited. (B.L.M.)

31775 CLINICAL CHEMISTRY. Kingsley, G. R. (Univ. of California, Los Angeles). Anal. Chem.; 43: No. 5, 15R-41R(Apr 1971).

Significant developments in clinical chemistry for the period December 1968 to November 1970 are reviewed. Examples of chemical analyses that might be adapted to clinical use are cited, i.e., determination of trace metals by activation analysis, determination of Na and Ca by flame photometry, and determination of P in serum by formation of the phosphomolybdate complex. Methods for the determination of biological substances, such as vitamins, enzymes, proteins, and lipids, are also reviewed. There are 851 references cited. (B.L.M.)

31776 FERTILIZERS. Gehrke, Charles W. (Univ. of Missouri, Columbia). Anal. Chem.; 43: No. 5, 64R-9R(Apr 1971).

Literature for the years 1969 and 1970 is reviewed, and 79 references are cited. Procedures included in readily available journals, in Chemical Abstracts, and in Analytical Abstracts that are pertinent to or that can be adapted to fertilizer analyses are included. Methods are included for H_2O, N, P, K, and micronutrients. (B.L.M.)

31777 FOOD. Foltz, Arthur K.; Yeransian, James A.; Sloman, Katherine G. (General Foods Technical Center, White Plains, N. Y.). Anal. Chem.; 43: No. 5, 70R-100R(Apr 1971).

Advances made in food analysis during the period October 1968 to October 1970 are reviewed, and 1176 references are cited. The subjects covered are additives, adulteration, contamination, decomposition, and food components, such as carbohydrates, fats, and proteins. (B.L.M.)

31778 FERROUS METALLURGY. Hines, C. R.; Dulski, T. R. (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chem.; 43: No. 5, 100R-8R(Apr 1971).

Development of analytical methods for ferrous metallurgy is reviewed for the period November 1968 to November 1970. The place of atomic absorption as the leading analytical tool is emphasized. Methods are described for the determination of the following elements: Al, Sb, As, Bi, B, C, Cr, Co, Cu, H, Pb, Mg, Mn, Mo, Ni, Nb, N, O, Se, Si, S, Ta, Te, Sn, Ti, W, V, Zn, Zr, rare earths, and nonmetallic inclusions. There are 548 references cited. (B.L.M.)

31779 NONFERROUS METALLURGY. I. LIGHT METALS: ALUMINUM, BERYLLIUM, TITANIUM, AND MAGNESIUM. Danchik, Richard S. (Aluminum Co. of America, New Kensington, Pa.). Anal. Chem.; 43: No. 5, 109R-19R(Apr 1971).

Material published from September 1968 to September 1970, limited to those analytical methods applied directly to materials of interest in the nonferrous metal industry, is reviewed. Methods referred to in the discussion along with other methods too numerous to mention individually are tabulated. There are 305 references cited. (B.L.M.)

31780 NONFERROUS METALLURGY. II. ZIRCONIUM, HAFNIUM, VANADIUM, NIOBIUM, TANTALUM, CHROMIUM, MOLYBDENUM, AND TUNGSTEN. Bachman, Robert Z.; Banks, Charles V. (Iowa State Univ., Ames). Anal. Chem.; 43: No. 5, 120R-45R(Apr 1971).

Methods for determination of Zr, Hf, V, Nb, Ta, Cr, Mo, and W are reviewed for July 1968 to July 1970. Methods for Zr and Hf are considered together, and spectrochemical methods are more numerous. There are 10 tables in which the various methods, such as spectrochemical, electrometric, and activation analysis for the different elements, are tabulated. There are 712 references cited. (B.L.M.)

31781 PESTICIDE RESIDUES. Thornburg, Wayne (Del Monte Corp. Research Center, Walnut Creek, Calif.). Anal. Chem.; 43: No. 5, 145R-62R(Apr 1971).

Publications readily available for the period November 1968 through October 1970 covering procedures useful for the analysis of pesticide residues are reviewed. The procedures are mainly improvements in existing techniques rather than completely new procedures. Emphasis was placed on instrumentation, especially gas chromatographic separation and determination of pesticides and their metabolites. There are 424 references cited. (B.L.M.)

31782 PETROLEUM. King, R. W. (Sun Oil Co., Marcus Hook, Pa.). Anal. Chem.; 43: No. 5, 162R-206R(Apr 1971).

Papers abstracted in Chemical Abstracts, American Petroleum Institute Refining Literature Abstracts, and in Analytical Abstracts (London) for the period July 1968 through June 1970 are covered. The review is divided into the following sections: crude oil; engine fuels; lubricants, oils, and greases; wax, asphalt; catalysts; physical properties; hydrocarbons; metal in oils; nonmetal elements and compounds; analytical and process instrumentation;

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and miscellaneous. Methods are reviewed for the elemental analysis of catalysts used in the petroleum industry. Colorimetric, x-ray emission, x-ray spectrophotometric, differential thermal analysis, and chemical procedures are some of the procedures referred to for the elemental analysis. Physical properties and activity tests of the catalysts are also reviewed. Methods for the determination of metals in crude oil include nuclear methods, atomic absorption, flame photometry, x-ray fluorescence, emission spectrometry, photometry, complexometric titration, amperometric titration, and others. Methods for the determination of halogens, N, O, and S in crude oils are reviewed. Methods for S include combustion, reduction, x-ray analysis, and neutron activation. Separation and determination methods for N compounds include ion exchange and chromatography followed by high-resolution, mass, ir, uv, and NMR spectrometry. A neutron activation method is also described for N. Methods are reviewed for determination of both total and dissolved O. Methods for both micro and macro amounts of halogens include polarography after combustion, nonaqueous potentiometric titration, neutron activation, and combustion followed by microcoulometric titration. The applications and uses of automatic process analyzers in refineries continues to be emphasized in this review. Automatic process control equipment is discussed briefly. Recent developments in automatically controlled processes are reviewed for elemental analyses, specific compound determination, analysis of light hydrocarbons, and determination of physical properties. Automatic titration instruments are reviewed. Certain applications of automation to specific parts of the petroleum industry are mentioned. There are 983 references cited for all sections. (B.L.M.)

31783 PHARMACEUTICALS AND RELATED DRUGS. Sutherland, J. W.; Williamson, D. E.; Theivagt, J. G. (Abott Labs., Chicago). Anal. Chem.; 43: No. 5, 206R-66R(Apr 1971).

Analytical methods and related topics of pharmaceutical interest that have appeared in the literature to June 1970 are surveyed. A tabular format is used for the methods applicable to alkaloids, antibiotics, inorganic and metal-organic compounds, nitrogen-containing compounds, oxygen-containing compounds, steroids and hormones, sulfur-containing compounds, vitamins, and formulations and mixtures. There are 2349 references cited. (B.L.M.)

31784 ANALYSIS OF HIGH POLYMERS. Mitchell, John Jr.; Chiu, Jen (E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.). Anal. Chem.; 43: No. 5, 267R-334R(Apr 1971).

Significant developments in polymer analysis during the past two years are reviewed. Techniques providing information on chemical and physical structure are stressed. No attempt was made to provide details of elastomer analysis. The areas of analysis reviewed are electrochemistry, ir and Raman spectrometry, magnetic resonance, mass spectrometry, x-ray methods, thermal methods, differential thermal analysis, thermogravimetry, gas chromatography, molecular weight determination and distribution, other chromatographic methods, and electrophoresis. There are 2390 references cited. (B.L.M.)

31785 RUBBER. Wadelin, Coe W.; Trick, Gordon S. (Goodyear Tire and Rubber Co., Akron, Ohio). Anal. Chem.; 43: No. 5, 334R-44R(Apr 1971).

Chemical analysis of rubber and the characterization of rubber by physical, chemical, and spectrometric methods are covered by this review, which cites 229 references. Methods for the characterization, identification, and determination of rubber and materials in rubber are included. Analysis of rubber chemicals before they are added to the rubber is not included. (B.L.M.)

31786 SOLID AND GASEOUS FUELS. Hattman, Elizabeth A.; Ortuglio, Carmen (Bureau of Mines, Pittsburgh). Anal. Chem.; 43: No. 5, 345R-56R(Apr 1971).

Methods of sampling, analyzing, and treating solid mineral and gaseous hydrocarbon fuels are reviewed for the two years ending October 1, 1970. Many of the methods involve nuclear techniques. Ninety-four references are cited. (B.L.M.)

31787 WATER ANALYSIS. Fishman, M. J.; Erdmann, D. E. (Geological Survey, Denver). Anal. Chem.; 43: No. 5, 356R-88R (Apr 1971).

Literature for the period October 1968 through September 1970 is surveyed and 631 references are cited. Methods are reviewed for the determination of alkali metals; hardness and alkaline earth metals; Al, Fe, Mn, Cr, Os, and Re; Cu, Zn, Pb, Cd, Ni, Co, Ge, and In; Hg, Au, and Ag; V, Zr, W, Mo, Sc, U, and rare earths; B, Se, As, and Sb; Cl^-, Br^-, and I^-; F^-; P and SiO_2; NO_3^-, NO_2^-, and nitrogen compounds; pH and alkalinity; O and other gases; detergents; pesticides and herbicides; organics; and radioactivity and isotopic analysis. (B.L.M.)

Chemical and Spectral Procedures

Refer also to abstracts 32062, 32209, 32211, 32290, 32296, 32297, and 32371.

31788 (CEA-N-1419, pp 3-90) CHEMICAL ANALYSIS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969-May 1970.

Research and development activities have included studies on the determination of Pu in U containing graphite by γ spectrometry, the effects of EDTA on the polarographic behavior of Pu, the effects of U on the spectrophotometric determination of Pu in HNO_3 solutions, parameters for the chromatographic separation of Nd in its determination in irradiated fuels, the analysis of U for impurities by emission spectrography, the analysis of Ti for impurities by atomic absorption spectroscopy, the analysis of Ta for iron by atomic absorption spectroscopy, x-fluorescence analyses of lanthanum chromites for La and Cr, $BaO-TiO_2$ for Ba and Ti, semiconductors for As and Te, Hastelloy for Mo and W, and vitreous materials for Al_2O_3, Fe_2O_3, and SiO_2. Nitrogen was determined in Zr and C in Zircaloy by fusion under inert gases. Resins were analyzed for Cu, Ni, Na, Zn, Zr, and Al by neutron activation, U for B by a volumetric method, and Mg-Mn alloys and Mg-Zr alloys for Al, Ca, Cr, Cu, Fe, Li, Mn, Ni, and Zn by atomic absorption spectrophotometry. (J.G.B.)

31789 (NIM-991) DETERMINATION OF THORIUM IN SOLID SAMPLES AND IN SOLUTIONS RESULTING FROM THE LEACHING OF ORES. Laboratory Method No. 90/10 (Revised). Steele, T. W.; Cook, E. B. T.; Russell, B. G. (National Inst. for Metallurgy, Johannesburg (South Africa)). 21 Aug 1970. 8p. Dep. NTIS (U. S. Sales Only).

The determination of thorium in carbonatite, baddeleyite, monazite, and alumina silicates, and in solutions resulting from the leaching of ores of similar composition is described. After fusion with sodium peroxide and dissolution of the resulting melt, thorium is separated by precipitation as the fluoride. The fluoride is decomposed with hot perchloric acid and the acid solution diluted to volume. In the presence of lanthanides, thorium is separated from an aliquot portion of this solution by liquid-liquid extraction of its acetylacetonate, and back-extraction into dilute hydrochloric acid. Thorium is finally determined in these solutions by a spectrophotometric method in which Arsenazo III is used as the colorimetric reagent. Thorium can be determined in the range of 0.01 to 12.80% of ThO_2 in solids and in the range of 0.08 to 10.00 g of ThO_2 per liter in solutions. The coefficient of variation of the method is 1.2% when fluoride separation only is used and 2.2% when liquid-liquid extraction is also used. (auth)

31790 (NIM-998) DETERMINATION OF MACROSCOPIC AMOUNTS OF TOTAL RARE-EARTH OXIDES AND THORIUM OXIDE. Laboratory Method No. 57/8. Steele, T. W.; Vollenweider, M.; King, R. H.; Wall, G. H.; Stoch, H. (National Inst. for Metallurgy, Johannesburg (South Africa)). 7 Aug 1970. 3p. Dep. NTIS (U. S. Sales Only).

The rare earths and thorium are separated from the mineral by two fluoride precipitations, hydroxide precipitation, and two oxalate precipitations. The oxalates are ignited to oxides and the oxides weighed. In analysis of monazite, the precision of the method was such that 95% of the results could be expected to fall within ±0.4%. (M.C.G.)

31791 (NIM-1043) DETERMINATION OF RUTHENIUM IN URANYL FLUORIDE. Steele, T. W.; Kruger, Magdalena M.; Wilson, Anita C. M. (National Inst. for Metallurgy, Johannesburg (South Africa)). 24 Aug 1970. 15p. Dep. NTIS (U. S. Sales Only).

A method for distillation of ruthenium was applied to the determination of ruthenium in uranyl fluoride. The distillation was carried out under oxidizing conditions, and the ruthenium was complexed with bathophenanthroline. The complex was then reduced and extracted with hexanol. A preliminary extraction of the iron-bathophenanthroline complex overcomes the interference of iron. (auth)

31792 (NIM-1044) DETERMINATION OF RUTHENIUM IN URANYL FLUORIDE. Laboratory Method No. 44/1. Steele, T. W.; Kruger, Magdalena M. (National Inst. for Metallurgy, Johannesburg (South Africa)). 24 Aug 1970. 6p. Dep. NTIS (U. S. Sales Only).

The method is applicable to the determination of ruthenium in

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uranyl fluoride in concentrations of up to 2 μg/g. The uranyl fluoride is mixed with an acid permanganate solution, and the ruthenium is distilled from it. After evaporation of the distillate, the iron-bathophenanthroline complex is formed at ambient temperature and extracted with hexanol. Further quantities of complexing and reducing agents are added to the aqueous phase, and the solution is heated to the boiling point before the ruthenium complex is extracted. The concentration of ruthenium is then determined spectrophotometrically. (auth)

31793 (PEL-203) URANIUM DETERMINATION IN ORE SAMPLES BY RADIOISOTOPE-EXCITED X-RAY FLUORESCENCE. Project X-Ray C16/69 NIM. Snyman, G. C.; Stewart, G. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Aug 1970. 8p. Dep. NTIS (U. S. Sales Only).

The quantitative determination of uranium in ore and liquid samples with a U_3O_8 concentration in the range 10 to 1000 ppM is described. A 100-mCi ^{57}Co source and a Ge(Li) detector were used for excitation and detection of the uranium K x rays. A lower limit of detection of 11.4 ppM uranium was achieved in a 5-minute count per ore sample. (auth)

31794 (RT/CHI-(70)44) LINEAR SWEEP VOLTAMMETRY OF Pu(VI)/Pu(V) REDOX SYSTEM IN NITRIC ACID. Casadio, S.; Riccardi, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Nov 1970. 15p. Dep. NTIS (U. S. Sales Only).

Voltammetric behavior of the Pu(VI)/Pu(V) redox system was studied in 1M HNO_3 by linear sweep voltammetry. The formal redox potential $E^0 = 675 \pm 5$ mV vs S.C.E. and the diffusion coefficient for the PuO_2^{2+} ion $D_{19°C} = (7.5 \pm 0.5) \cdot 10^{-6}$ cm²/sec were obtained. Analytical implications are discussed. (auth)

31795 (UCRL-72508) DETERMINATION OF CALCIUM, IODINE, AND PHOSPHORUS DISTRIBUTIONS IN THYROID GLANDS BY ELECTRON-PROBE MICROANALYSIS. Robison, William L.; Van Middlesworth, Lester (California Univ., Livermore. Lawrence Radiation Lab.). 16 Jun 1970. 36p. (CONF-700621-2). Dep. NTIS.

From sixth international thyroid conference; Vienna, Austria (22 Jun 1970).

Electron probe microanalysis methods were used to analyze thyroid gland tissue for Ca, I, and P. Data on elemental distributions are given in tables and graphs. (M.C.G.)

31796 STANDARD METHOD OF TEST FOR ASH IN GRAPHITE. ASTM C 561-69. Philadelphia; American Society for Testing and Materials (1969). 2p. Available from American Society for Testing and Materials, Philadelphia.

Ash in graphite was determined by ignition at 750°C in a Pt dish until no black specks indicated C, and then at 950°C for 1 hr. The net weight of the residue leads directly to calculation of ash content. (B.L.M.)

31797 VOLUMETRIC DETERMINATION OF THALLIUM, INDIUM, AND YTTERBIUM. Verdizade, A. A.; Mekhtiev, M. M.; Verdizade, N. A. Uch. Zap. Azerb. Gos. Univ., Ser. Khim. Nauk; No. 2, 32-6(1969). (In Russian).

A titrimetric method is proposed for the determination of Tl, In, and Yb in compounds of the types $InYbS_3$, $InYbSe_3$, and $TlYbSe_3$. The $TlYbSe_3$ sample is dissolved in HNO_3, and thallium is precipitated with KIO_4. The precipitate is separated and dissolved with HCl. Benzene and KI are added, and the liberated iodine is titrated with $Na_2S_2O_3$. Yb and Tl are determined iodometrically. Similar procedures were followed for the analysis of $InYbS_3$ and $InYbSe_3$. (Referativnyi Zh.)

31798 DIPHENYLDIMERCAPTOTHIOPYRONE [2,6-DIMERCAPTO-3,5-DIPHENYLTHIOPYRAN-4-ONE]. A NEW REAGENT FOR THE PHOTOMETRIC DETERMINATION OF TRACES OF TELLURIUM. Tutkuvene, V. E.; Ramanauskas, E. I.; Arishkevich, A. M.; Usatenko, Yu. I. Liet. TSR Aukst. Mokyklu Mokslo Darb., Chem. Chem. Technol.; No. 9, 55-60(1968). (In Russian).

This reagent (I) forms a red 4 : 1 complex with Te over a wide range of acid concentrations (0.02 to 0.7 N in HCl). At HCl concentrations > 0.02 N, the absorption spectrum of I has a minimum at 360 nm, and the difference between the extinction due to the complex and to I is almost at its maximum. The molecular extinction coefficient of the complex at 360 nm is 17,780, and the sensitivity of the reaction is 7 ng/cm². Te is determined by adding 1 ml of a 0.5% solution of OP-10 emulsifying agent (to stabilize the complex), 2 ml of 0.03% solution of I (I is dissolved in 0.5 N NaOH and diluted to desired concentration), and sufficient HCl to make the final volume of solution 0.2 N HCl to a test solution containing 2 to 35 μg of Te. The mixture is diluted to 25 ml, and the extinction measured at 360 nm (5-cm cell) against a blank. The error is within ±6%. Cobalt, Cr(III), Ni, Al, Zn, Sb(V), Th, Ba, Ca, Si, and Mn(II) do not interfere, but Se(VI), Sb(III), Hg(II), Pb, Cu, Fe(III), and As(V) do. (Referativnyi Zh.)

31799 MASS-SPECTROMETRIC ANALYSIS OF THE ISOTOPIC COMPOSITION OF SOME TRANSITION ELEMENTS (TITANIUM, CHROMIUM, IRON, ZIRCONIUM, MOLYBDENUM, MERCURY). Knyazev, D. A.; Bantysh, A. N.; Ivlev, A. A.; Kliniskii, G. D.; Preobrazhenskaya, L. B. (Chemical-Technical Inst., Moscow). Isotopenpraxis; 6: 406-9(Nov 1970). (In Russian).

Molybdenum and chromium in the form of the oxychlorides MoO_2Cl_2, $MoOCl_4$, and CrO_2Cl_2 were analyzed by the masses of MoO^+ and Cr^+ ions. An ampule of MoO_2Cl_2 ($MoOCl_4$) was thermostated at a temperature ranging between 30 and 40°C. The two-channel method used with a standard system for recording the ion currents (MI-1305) gave an accuracy of 0.3%. Titanium tetrachloride was analyzed by masses of Ti^+ ions. For analyzing zirconium, boron tetrahydride $Zr-Zr(BH_4)_4$ was used as a working agent, which rendered possible suppression of the influence of the mercury background in the instrument. Iron was analyzed in the form of pentacarbonyl $Fe(CO)_5$ by the masses of Fe ions. Accuracy of two-channel measurements amounted to 0.3%. Methods for MoO_2Cl_2, $MoOCl_4$, CrO_2Cl_2, and Fe(CO)/microsynthesis were developed. (auth)

31800 HYDROGEN ISOTOPE SPECTRAL ANALYSIS OF SOME HYDRIDES. Nedumova, E. S.; Andreev, B. M.; Domanov, M. M.; Labachev, Yu. S.; Maslov, D. (Chemical-Technical Inst., Moscow). Isotopenpraxis; 6: 412-17(Nov 1970). (In Russian).

The possibility of spectral analysis of the compounds H_2, H_2O, NH_3, and H_2S by means of the diffraction spectrograph of the DS-1 monochromator, with photoelectric recording of the blue line of the Balmer series was investigated. A radiofrequency discharge served as a light source. Optimum conditions for analysis of the compounds were explored by the results of the investigation carried through to determine the dependence of the intensity of the protium and deuterium lines on the pressure inside the discharge tube. The calibration plots found render possible determination of the isotopic ratio of hydrogen in the deuterium concentration range from 1 to 99% with an accuracy of 1 or 1.5% (relative). In the mean concentration range the error drops to 0.5%. (auth)

31801 APPLICABILITY OF GAS-CHROMATOGRAPHY TO THE ANALYSIS OF LIGHT METALS. Cremer, E.; Deutscher, F. (Univ., Innsbruck). pp 24-6 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

With the exception of alkali metals, all metals, after conversion to organometallic compounds, can be microanalyzed by gas chromatography below 450°C. The difficulties encountered with the alkali metals are due first to the high boiling points of these metals and their inorganic compounds and second to the poor stability of their organic compounds. No separation can be effected by increasing the temperature range up to 800°C because of the high irreversible absorption capacity of the column-filling material. (auth)

31802 SPECTROPHOTOMETRIC DETERMINATION OF ZIRCONIUM(IV), AND FLUORINE WITH GALLEIN. Mori, Itsuo (Osaka Coll. of Pharmacy). Jap. Anal.; 20: 282-7(Mar 1971). (In Japanese).

The color development of a water-soluble reddish violet complex between gallein and zirconium(IV) was enhanced by the catalytic action of fluorine, particularly in the coexistence of excessive cetylpyridinium chloride(CPC), which decreased the reagent blank of gallein and increased the absorbance of the complex. Its absorption maximum was at 600 mμ against the reagent blank, and the absorbance was constant over the pH range from 3.8 to 4.8 in the coexistence of 1.0×10^{-3}M CPC. The calibration curve was linear for 0 to 20 μg of zirconium(IV), and 0.5 to 3.8 μg of F^-. The recommended analytical procedure is as follows: to the solution of zirconium(IV) are added 1.5 ml each of 1.0×10^{-2}M CPC, 4.0×10^{-3}M sodium fluoride solution and 1.5×10^{-3}M methanolic gallein solution, and 2.0 ml of sodium acetate-acetic acid buffer of pH 4.6; to the solution of F^- are added 0.5 ml of 5.0×10^{-4}M zirconium(IV), and 1.5×10^{-3}M methanolic gallein solution and 2.0 ml of the buffer of pH 4.6; the solution then diluted to 10 ml with water and, after 30 minutes, the absorbance measured at 600 mμ for zirconium(IV), and 610 mμ for F^- against the reagent. Many ions interfere with the determination. (auth)

31803 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM BY UTILIZATION OF COMPLEXATION IN THE MI-

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CELLE SOLUTION OF QUATERNARY AMMONIUM SALT. Shijo, Yoshio (Univ. of Utsunomiya, Japan); Takeuchi, Tsugio. Jap. Anal.; 20: 297-302(Mar 1971). (In Japanese).

Chromeazurol S(CAS) reacts sensitively with uranium(VI) to form a blue complex in a micelle solution of trimethylcetylammonium chloride. The absorption maximum of this complex was at about 615 mμ, and the pH dependence of the absorbance became small at pH 4 to 5.5. The calibration line at 615 mμ was slightly curved but that at 625 mμ was quite linear with apparent molar absorptivity 1.0×10^5. The continuous variation measurement indicated that the composition of the complex was U : CAS = 1 : 2. The acid dissociation of CAS in a micelle solution of trimethylcetylammonium chloride was remarkably enhanced in the acid solution but it seemed to be suppressed in the alkaline side. (auth)

31804 SPECTROPHOTOMETRIC DETERMINATION OF IODIDE IONS BY SOLVENT EXTRACTION WITH NEUTRAL RED. Tsubouchi, Masahiro (Tottori Univ., Japan). Bull. Chem. Soc. Jap.; 44: 554-5(Feb 1971).

A new spectrophotometric method for the determination of iodide ions is given. It is based on solvent extraction of the ion pair formed between the colored neutral red cation and colorless iodide ion. (D.P.O.)

31805 N-BENZENESULPHONYL β-ALANINE AS A MASKING AGENT FOR Hg(II). Ghosh, Nripendra Nath; Bhattacharyya, Anjali (University Coll. of Science, Calcutta). Bull. Chem. Soc. Jap.; 44: 407-8(Feb 1971).

N-Benzenesulfonyl glycine and N-benzenesulfonyl α-alanine form water soluble complexes with Hg(II), Cu(II), and Ag(I). But N-benzenesulfonyl β-alanine ($R_b^\beta H_2$) gives only stable complex ion $Hg(R_b^\beta)_2^{2-}$, showing that $R_b^\beta H_2$ is a highly selective masking agent for Hg(II). Utilizing this masking property, methods for detection and determination of Hg(II) were developed. $R_b^\beta H_2$ reacts with Hg(II) at pH ≈ 8, yielding the ion $Hg(R_b^\beta)_2^{2-}$ and on subsequent treatment with KI, two equivalents of alkali are liberated. On titrating the alkali liberated with a standard acid, the amount of Hg(II) may be calculated. Interferences due to diverse ions were studied; Br^- and I^- interfere. The spot test of Hg(II) based on the same principle has been developed and it appears to be specific under specified conditions. The limit of identification is 0.5 μg with a dilution limit of 1 : 100000. (auth)

31806 DETERMINATION OF SMALL AMOUNTS OF HAFNIUM, COBALT, COPPER, AND TUNGSTEN IN ZIRCONIUM AND ZIRCONIUM ALLOYS BY FLUORESCENT X-RAY ANALYSIS. Nakajima, Tokunosuke; Ouchi, Yoshihiko; Kato, Kaneharu (Japan Atomic Energy Research Inst., Tokai). Jap. Anal.; 20: 330-5 (Mar 1971). (In Japanese).

The analytical conditions for the fluorescent x ray determination of small amounts of Hf, Co, Cu, and W in zirconium and Zircaloy were established. An x ray tube with a platinum target was used as the primary excitation source. Counting system of the single channel x ray fluorescence spectrometer (GE-XRD-5 spectrometer) was replaced with solid-state signal processing electronics (JAERI nuclear instrument module system), which eliminate difficulties of noise and drift at the linear amplifiers and pulse height analyzer, contributing to increase the detectabilities of minor elements. In order to eliminate the interference from contaminated copper spectra, occurring at copper analysis, cobalt filter was inserted between the primary x ray tube and the sample. Copper filter was all the same effective for the determination of tungsten in order to reduce the interference from the primary $PtL\alpha_1$ line. The limits of detection of Hf, Cu, Co, and W were estimated to be ca. 40, 10.4, 8.2, and 15 ppM, respectively. Reproducibilities obtained were 6.9% for Hf, 2.7% for Cu, 3.1% for Co, and 6.4% for W. (auth)

31807 POLAROGRAPHIC DETERMINATION OF URANIUM BY EXTRACTION SEPARATION. Shinagawa, Mutsuaki (Osaka Univ.); Katsura, Kosho. Nippon Genshiryoku Gakkaishi; 13: 114-21(Mar 1971). (In Japanese).

Uranyl tribenzoate, formed in benzoate–benzoic acid media, was extracted into chloroform in combination with quaternary ammonium salts (dimethylbenzylphenylammonium chloride (DMBPAC), triethylbenzylammonium chloride (TEBAC), and triethylphenylammonium chloride (TEPAC) at pH 2.5 to 5.5 in the ratio of 1 : 1. The plot of logD against pH indicated third power dependence of pH. Similar plots of logD vs. $\log[B^-]$ also showed a slope of 3. The ratio of uranyl, benzoate, and quaternary ammonium was 1 : 3 : 1. It is suggested that uranyl tribenzoate had formed an ion association complex with quaternary ammonium cations. The extraction of uranium is seriously impaired by the presence of WO_4^{2-}(10^{-3}M) and Cu(II)(10^{-2}M), and these impurities must be carefully eliminated. Over 90% of U was extracted in the presence of Fe(III), La(III), Sr(II), Ca(II), Mg(II), Ni(II), Zn(II), Co(III), (10^{-2}M each), AsO_3^{3-}(10^{-3}M), or Th(IV)(10^{-3}M). Uranium in the chloroform was quantitatively back extracted with 0.5M sulfuric acid, and was determined by polarographic method. (auth)

31808 SPECTROPHOTOMETRIC DETERMINATION OF TELLURIUM IN STEELS AND CAST IRONS. Maneschi, S.; Gallazzi, C. (Centro Sperimentale Metallurgico, Rome). Anal. Chim. Acta; 54: 461-7(May 1971).

A method for determination of tellurium in steels and cast irons is described. The conditions for separation of tellurium from the metallic matrix by precipitation as the element with tin(II) in hydrochloric acid medium and its subsequent filtration were examined. Tellurium is then dissolved and reprecipitated in a colloidal form for spectrophotometric determination. The method is free of interferences from elements commonly present in steels and cast irons, except for arsenic in amounts above 500 μg; chromium and graphitic carbon do not interfere. The procedure is suitable for tellurium in the range 0 to 140 μg. (auth)

31809 SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM(III) WITH TROPOLONE BY SOLVENT EXTRACTION. Rizvi, G. H.; Gupta, B. P.; Singh, R. P. (Univ. of Delhi). Anal. Chim. Acta; 54: 295-302(Apr 1971).

Ruthenium(III) reacts with tropolone in aqueous medium at pH 4.5 to 6.0 to yield a yellow 1 : 2 complex, which can be extracted with chloroform and has an absorbance maximum at 415 nm. Full color development requires heating for 10 min on a water bath; the color is then stable for days. Beer's law is obeyed in the range 0 to 5.7 ppM of ruthenium. The molar absorptivity is $1.87 \cdot 10^4$ l mole^{-1} cm^{-1}. Common anions do not interfere. Of 37 cations examined, only Fe(III), V(V), U(VI), Rh(III), and Pd(II) interfere; these interferences can be avoided by a preliminary extraction of the tropolone complex of the interfering metal, or by measuring the absorbance at 480 nm. (auth)

31810 QUANTITATIVE SEPARATION AND DETERMINATION OF THE COMPONENTS IN HEAVY RARE EARTH METAL SUBSTITUTED GARNETS. Tanos, F. (Research Inst. for Telecommunication, Budapest). pp 51-7 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838–(Vol.1).

A cation exchange chromatographic process was developed for investigation of polycrystalline Y–Fe garnets and garnet single crystals of the basic composition $3Y_2O_3 \cdot 5Fe_2O_3$. After absorption of the metal ions on the resin column in the hydrogen form, Y and the rare earth metal ions were eluted with ammonium α-oxyisobutyrate solution of various pH values and concentrations. Y can be satisfactorily separated from the heavy lanthanides with the exception of Ho and Dy by a stepwise pH gradient elution. Continuous pH gradient elution was unsatisfactory for the separation of the heavy lanthanides, but the lighter members of the series from Gd to La were separated by continuous pH variation or continuous gradient elution. The distribution coefficients of the metals are shown graphically vs pH, and the separation coefficients calculated from the elution data are tabulated. (B.L.M.)

31811 APPLICATION OF ALKYLPHOSPHORIC ACIDS IN THE ANALYSIS OF SUBSTANCES CONTAINING RARE EARTHS. Mohai, M.; Upor, E.; Klesch, K. (Mecsek Mining Co., Hungary). pp 81-6 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838–(Vol.1).

On the basis of the varying extraction of different ions with dibutyl phosphate (HDBP) it is possible to separate the rare earths from other ions. The equilibrium constants for HDBP and several ions and some important distribution ratios are tabulated, as are the separation factors required by the allowed amount of interfering substances and the main features of the individual methods for the separation of rare earths. Specific separations and other applications of alkylphosphoric acid extraction are discussed. (B.L.M.)

31812 ANALYTICAL SEPARATION AND ANALYSIS OF A MULTICOMPONENT SYSTEM BY ELECTRON PARAMAGNETIC RESONANCE. Guilbault, G. G.; Moyer, E. S. (Louisiana State Univ., New Orleans). pp 199-208 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838–(Vol.1).

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A procedure is described for the separation by ion selective complexing reagents, which can be extracted into organic solvents, or selective precipitation and EPR measurements for the determination of Cr(III), Mn(II), VO(II), Fe(III), Cu(II), and Gd(III). The range of analytical utility and the lower limit of detection for the ions or radicals by EPR analysis are tabulated. (B.L.M.)

31813 SOME EXPERIENCES WITH THE PYROHYDROLYTIC SEPARATION OF MICRO-AMOUNTS OF FLUORIDE FROM SPECIAL-GLASSES. Lange, J. (Special Glassworks, Weisswasser, Ger.). pp 239-45 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

A pyrohydrolytic method was applied to the separation of fluoride from glass samples in the presence of a catalyst, such as U_3O_8, WO_3, or V_2O_5, using steam as a carrier. Fluoride was volatilized as H_2F_2 or H_2SiF_6, condensed along with the steam, and determined photometrically. The temperature of the expulsion varies with the content of the glass sample. For samples with a high Pb content, the expulsion temperature must be <900°C to prevent a positive error due to volatilization of lead oxide while for non-lead-containing glass 1150°C was the optimum temperature. The metal oxides at a 1:1 ratio of oxide to glass not only serve as a catalyst but prevent the glass grains from melting together. A glass grain size of <0.5 mm was found to be conducive to maximum expulsion of fluoride. (B.L.M.)

31814 INVESTIGATION OF ALKALI AND AMMONIUM TETRAPHENYLBORATES BY INFRARED SPECTROPHOTOMETRY. Kiss-Eross, K. (Technical Univ., Budapest); Buzas, I.; Erdey, L. pp 47-54 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 2. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.2).

The ir spectra of ammonium tetraphenylborate contains many more bands than the spectra of alkali metal tetraphenylborates. Thus ammonium ions can be determined in the presence of alkali metals without separation by precipitation of the combined tetraphenylborates and ir spectral analysis of the precipitates. (B.L.M.)

31815 CHEMICAL STUDIES OF MINERALS CONTAINING RARER ELEMENTS FROM THE FAR EAST DISTRICT. LXIV. ABUKUMALITE FROM FUSAMATA, KAWAMATA-MACHI, FUKUSHIMA PREFECTURE, JAPAN. Nagashima, Kozo; Nakao, Kazuso; Wakita, Hisanobu; Kato, Akira (Tokyo Kyoiku Univ. National Science Museum, Tokyo). Bull. Chem. Soc. Jap.; 44: 867-9(Mar 1971).

Chemical analysis was carried out on abukumalite. X-ray powder data for abukumalites from Suishoyama and Fusamata and synthetic $Ca_4Y_6Si_6O_{24}(OH)_2$ are given. The distribution patterns of the lanthanoids from the two abukumalites showed them to be members of the thalenite type. (D.P.O.)

31816 DETERMINATION OF TIN IN TIN METAL AND IN ZIRCALOY BY PRECISE COULOMETRIC TITRATION. Yoshimori, Takayoshi; Matsubara, Ikuko; Tanaka, Tatsuhiko; (and others) (Science Univ. of Tokyo). Bull. Chem. Soc. Jap.; 44: 734-7 (Mar 1971).

The purities of tin metals are determined directly by precise coulometric titration. The sample is dissolved with hydrochloric acid in a nitrogen atmosphere. The solution is then introduced into a hot antimony column. The reduced tin(II) ions are titrated with electrolytically generated iodine. The titration is accomplished in a special cell in which any disturbance by atmospheric oxygen is avoided. The titration efficiency in these acidic media decreased when the current density was increased more than several mA/cm^2. The results obtained by two different analysis for the sample of the pure tin metal (5-nine) were 99.996 and 99.991%. The standard deviations of the results were 0.025 and 0.016% respectively. Tin in other tin metals and in Zircaloy samples was determined satisfactorily without the use of any experimental factor. (auth)

31817 ULTRAMICRO ELEMENTAL ANALYSIS. Toelg, Guenther. Chemical Analysis. Volume 30. A Series of Monographs on Analytical Chemistry and Its Applications. New York; John Wiley and Sons, Inc. (1970). 211p. $10.95.

Translated by Conrad E. Thalmayer.

Measurement and manipulation of ultramicro samples and general decomposition procedures are discussed. The elements that are determined, either alone or in combination with other elements, by the procedures described are: C, H, O, N, S, F, Cl, Br, I, P, and As. No attempt is made to discuss the basic theory. (D.P.O.)

31818 DETERMINATION OF RETAINED FISSION XENON IN NUCLEAR FUELS. Koch, L.; De Meester, R. (Europaeisches Institut fuer Transurane, Karlsruhe, Ger.). Radiochim. Acta; 15: 133-5(Apr 1971). (In German).

The fission xenon retained in nuclear fuels is determined by wet chemical dissolution of fuel element samples and by isotope dilution analysis. ^{129}Xe only abundant in natural xenon is used as a spike. The sample dissolution, purification of gases, and the determination of xenon amount are described. The accuracy of the method is 3%. (auth)

31819 SPECTROCHEMICAL ANALYSIS OF TELLURIUM. Zmbova, B. (Boris Kidric Inst. of Nuclear Sciences, Vinca, Yugoslavia). Isotopenpraxis; 7: No. 2, 57-9(Feb 1971).

A spectrochemical method was developed for analysis of impurities in tellurium targets used for production of ^{131}I. The method uses a preconcentration of impurities on a graphite base by vacuum distillation of Te. Ga, In, Be, Mn, Pd, Zr, Rh, Ti, Pb, Cr, Sn, Mg, Fe, Bi, Al, Ag, Ni, Co, Pt, and Sb were determined in the concentration range 2×10^{-4} to 1×10^{-2}% with samples of 1 g Te. (auth)

31820 FLUORESCENT X-RAY ANALYSIS OF ZIRCONIUM ALLOY. Nakajima, Tokunosuke (Japan Atomic Energy Research Inst., Tokai). Bunseki Kiki; 8: 717-27(Nov 1970). (In Japanese).

Fluorescent x-ray analysis is highly effective for analysis of the constituting elements in zirconium alloys, such as Fe, Ni, etc., and the impurity elements such as Hf, Cu, etc. Analytical results for Sn, Fe, Ni, Cr, and Nb are given. For analysis for the trace elements in the zirconium alloy, spectral problems are explained for Hf, Co, Cu, and W; an example of their analysis is given. Finally, the x-ray fluorescence analog and digital signal processing electronics prepared are discussed. (Japan)

31821 POLAROGRAPHIC DETERMINATION OF ZIRCONIUM(IV) AS 7-NITRO-8-HYDROXYQUINOLINE-5-SULPHONATE. Gupta, S. L.; Raghavan, P. S. (Birla Inst. of Tech. and Science, Pilani, India). Indian J. Chem.; 8: 1033-4(Nov 1970).

An indirect polarographic method was employed for the estimation of zirconium (IV) using 7-nitro-8-hydroxyquinoline-5-sulfonic acid (NOSA) as a precipitant at pH 1.5, as direct amperometric titration is not found suitable. The precipitate is dissolved in 0.1M NaOH and the solution buffered (pH 8.5) with boric acid and polarographed after adjusting the ionic strength to 0.54M KCl. The precipitant associated with zirconium (IV) was determined using the reduction wave of the nitro group of NOSA. The composition of the precipitate was found to be $Zr(NOSA)_4$. Effect of added foreign ions has been studied. Error in most cases is ±2%. (auth)

31822 STANDARD REFERENCE MATERIALS FOR THE ANALYSIS OF ENVIRONMENTAL SAMPLES. Marlow, W. F. (Atomic Energy Commission, Washington, D. C.); Lafleur, P. D. pp 91-4 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The US Atomic Energy Commission and the US National Bureau of Standards have instituted a program for the production of a series of special Standard Reference Materials, fully characterized for at least 22 and possibly 30 elements, suitable for use in the analysis of environmental samples, particularly biological samples. These Standard Reference Materials will be available for purchase by all laboratories. Multilaboratory intercomparisons of these Standard Reference Materials will be encouraged. Details of the nature of these materials, elements for which they will be characterized and analytical techniques used in standardizing them are discussed. (auth)

31823 FEASIBILITY OF RADIOISOTOPE X-RAY FLUORESCENCE ANALYSIS FOR MEASURING WATER POLLUTION BY MEALS. Florkowski, T.; Holynska, B.; Niewodniczanski, J. (Inst. of Nuclear Techniques, Krakow). pp 335-45 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The possibility of using radioisotope x-ray fluorescence analysis for determination of metal content in water is being investigated. The limit of detection for several metals in water has been established as 5 ppM with the use of ^{238}Pu, ^{109}Cd, and ^{241}Am sources. The quick chemical extraction of metal ions with

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organic solution followed by x-ray fluorescence analysis is proposed for concentrations below 1 ppM. An immersion probe for continuous or discrete measurements of metals in water in concentrations above 5 ppM is suggested. (auth)

31824 INVESTIGATION OF THE ANALYTICAL CAPABILITIES OF X-RAY EMISSION INDUCED BY HIGH ENERGY ALPHA PARTICLES. Watson, R. L.; Sjurseth, J. R.; Howard, R. W. (Texas A and M Univ., College Station). Nucl. Instrum. Methods; 93: No. 1, 69-76(1971).

A beam of 50-MeV alpha particles has been used to induce x-ray emission in thin targets of Cu, Sn, and Pb. A high resolution Si(Li) spectrometer system was used to measure the spectra of x rays and a study of the variation of the photopeak to background ratio as a function of target thickness was carried out for the purpose of estimating the analytical sensitivity of the technique. The results indicated that quantitative analyses at a level of the order of 50 ppM are possible for elements from Z = 22 to Z = 50 and at a level of the order of 130 ppM for elements of Z > 50. Applications of the technique to the determination of thin film thicknesses and to the analysis of air filters are demonstrated. (auth)

31825 CHRONOPOTENTIOMETRIC AND ELECTRODE POTENTIAL INVESTIGATIONS IN MOLTEN EQUIMOLAR SODIUM AND POTASSIUM METAPHOSPHATES. Wolfe, Clinton R.; Caton, Roy D. Jr. (Univ. of New Mexico, Albuquerque). Anal. Chem.; 43: 663-70(May 1971).

Electrode potential investigations of V(V)/V(IV), U(VI)/U(IV), and Cu(II)/Cu(I) were conducted in equimolar $NaPO_3$–KPO_3 at 700°C and the values of the formal electrode potentials vs. the one molal $AgPO_3$ reference electrode were determined to be 0.394, 0.0976, and −0.121 volts, respectively. The number of electrons involved in the potential-determining electrochemical reactions were calculated from the Nernst slopes to be 1, 2, and 1 for V(V)/V(IV), U(VI)/U(IV), and Cu(II)/Cu(I), respectively. Chronopotentiometric measurements in the same solutions that were used in the electrode potential studies indicated that the method can be used for analysis with a precision of better than 3%. The diffusion coefficients of V(V), U(VI), U(IV), Cu(II), Cu(I), and Ag(I) were determined to be 1.69×10^{-6}, 1.26×10^{-7}, 0.318×10^{-7}, 0.460×10^{-6}, 7.00×10^{-6}, and 1.09×10^{5} cm^2 sec^{-1}, respectively. (auth)

31826 FLUOROMETRIC DETERMINATION OF SUBMICROGRAM QUANTITIES OF ANTIMONY. Filer, T. D. (Atomic Energy Commission, Idaho Falls, Idaho). Anal. Chem.; 43: 725-9(May 1971).

A fluorometric procedure for the determination of antimony using 3,4',7-trihydroxyflavone has been developed that is much more sensitive than other common methods. The fluorescence of the antimony (III) complex is measured in a perchloric acid solution using phosphate as a masking agent. The method has a detection limit of 0.04 μg, a precision to about 2% on 5 μg, and excellent tolerance to most common elements. After decomposition of the sample by pyrosulfate fusion, the antimony is extracted as the triiodide into methyl isobutyl ketone from a sulfuric acid solution. (auth)

31827 DETERMINATION OF TITANIUM BY CONTROLLED-POTENTIAL COULOMETRY. Rigdon, L. P.; Harrar, J. E. (Univ. of California, Livermore). Anal. Chem.; 43: 747-51 (May 1971).

A procedure was developed for the determination of titanium by means of controlled-potential coulometry. The method is based on the reduction of Ti(IV) to Ti(III) at −0.20 V vs. SCE in 9M H_2SO_4. Background corrections are low, and samples containing 0.1 to 10 mg Ti per ml can be analyzed with an accuracy and precision of 0.1 to 0.2%. The Ti(IV)–Ti(III) couple is reversible, thus by reoxidizing the Ti(III) to Ti(IV) at +0.22 V, the quantity of each oxidation state can be determined and certain interferences can be avoided. Principal interferences are As(III), Bi(III), Cu(II), Mo(VI), Se(VI), and Te(IV). Five mg of Ti can be determined accurately in the presence of >5 mg Nb, >4 mg Zr, 5 mg V, 0.2 mg W, 2 mg Fe, or 0.5 mg Cl^-. The method has been applied to the analysis of Ti–W alloys of high tungsten content, after separation of the titanium by hydrolytic precipitation. (auth)

Isotope Dilution Procedures

Refer also to abstract 34352.

31828 (CEA-R-4100) DISPLACEMENT AND ITS POSSIBILITIES OF APPLICATION TO RADIOELEMENT ANALYSIS BY ISOTOPIC DILUTION. Colomer, Jean; Cousigne, Michel; Metzger, Gilbert (Commissariat a l'Energie Atomique, Bruyeres-le-Chatel (France). Centre d'Etudes). Mar 1971. 23p. (In French). Dep. NTIS (U. S. Sales Only).

A method of liquid phase chromatographic analysis based on the principle of substoichiometry (development by displacement and solvent extraction) combined with on-line radiometric detection by scintillation or by Cerenkov effect is described. The first results are reported and application prospects discussed. (France)

Radiometric and Radiochemical Procedures

Refer also to abstracts 32085, 32174–32179, 32223, 32234, 32280, 32288, 32304, 32350, 32395, 33057, and 33413.

31829 (AAEC/TM-569) DETERMINATION OF ^{65}Zn IN LUCAS HEIGHTS EFFLUENT. Isaacs, S. R. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Oct 1970. 14p. Dep. NTIS (U. S. Sales Only).

A method for quantitative determination of ^{65}Zn in effluent is described. The ^{65}Zn is selectively extracted from a concentrate of effluent in HCl using Aliquat-336 in xylene. The extracted ^{65}Zn is determined by gamma spectrometry. Using an 8 in. × 4 in. NaI (Tl) crystal, concentrations as low as 0.07×10^{-12} Ci/ml can be determined, with ±10% statistical accuracy. (auth)

31830 (FRL-6) DETERMINATION OF RADIOCAESIUM IN SEA AND FRESH WATERS. Dutton, J. W. R. (Ministry of Agriculture, Fisheries and Food, Lowestoft (England). Fisheries Radiobiological Lab.). Oct 1970. 9p. Dep. NTIS (U. S. Sales Only).

Two simple one-step separations of radiocaesium from sea and fresh waters are described, using either ammonium dodecamolybdophosphate (AMP) or potassium cobaltihexacyanoferrate (KCFC). Cesium-137 and -134 are measured by gamma-counting the dried material, using a sodium iodide(Tl) crystal coupled to a gamma spectrometer. The methods are extremely simple, and enable caesium-137 at levels down to about 1 pCi/l (depending on the volume of water used) to be determined in rain, river, lake, and sea waters without recourse to sophisticated chemical techniques. (auth)

31831 (HASL-242, pp I.79-84) THE QUALITY OF GAMMA SPECTRAL ANALYSES IN THE HASL SURFACE AIR SAMPLING PROGRAM DURING 1970. Kleinman, Michael T.; Volchok, Herbert L. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970–March 1, 1971.

A limited number of data indicate that ^{95}Zr, ^{137}Cs, and ^{144}Ce analyses of surface air samples by Ge(Li) diode spectrometry compare with radiochemical analysis on the same samples to within about 25%. The diode results appear to be higher for ^{137}Cs and lower for ^{144}Ce than the chemistry results. (auth)

31832 (ORNL-tr-2487) ALKALI CHLORIDE ELECTROLYSIS STUDIES BY TRACER TECHNIQUES. Balla, Bela; Kalman, Laszlo. Translated by Francois Kertesz for Oak Ridge National Lab., Tenn., from Kem. Kozlem.; 32: 173-8(1969). 7p. Dep. NTIS.

A radioisotopic method for determination of mercury in electrolytic cells is described. Uses of ^{198}Au and ^{203}Hg were evaluated for determining the amount of mercury and ^{203}Hg chosen. (M.C.G.)

31833 (RT/CHI-(70)38) DETERMINATION OF THE COMPOSITION OF THE MIXTURE ^{95}Zr–^{95}Nb BY MEANS OF ANTHRACENE SCINTILLATION COUNTER. Baroncelli, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 Oct 1970. 17p. (In Italian). Dep. NTIS (U. S. Sales Only).

Counting by use of a standard anthracene scintillation counter enables an accurate determination of ^{95}Zr in Zr–Nb mixtures. A check of the radiochemical purity of both nuclides is described. The procedure is particularly suitable for the percentage determination of the two radioactive isotopes in organic solvent and in aqueous solutions at low salt concentrations. (auth)

31834 DETERMINATION OF ^{210}Po IN URINE. De Boeck, R.; Adams, F.; Hoste, J. (Univ., Ghent). Health Phys.; 20: 403-7 (Apr 1971).

A procedure for the determination of ^{210}Po in urine is described. The method uses wet ashing with HNO_3 and $HClO_4$ acid, extraction of ^{210}Po from the remaining solution with benzohydroxamic acid in $CHCl_3$ and a back-extraction from the organic phase with 1 N HCl. The yield is about 98.1% and is reproducible. Samples up to 500 ml can be analyzed. In the experimental conditions described, the sensitivity is ±0.05 pCi. (auth) (UK)

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31835 LIQUID SCINTILLATION COUNTING OF ^{3}H AND ^{32}P RNA IN SLICES OF POLYACRYLAMIDE GELS. Hellung-Larsen, Per (Biokemisk Institut, Copenhagen). Anal. Biochem.; 39: 454-61(Feb 1971).

^{3}H- and ^{32}P-RNA in slices of polyacrylamide gels crosslinked with bisacrylamide were digested with NCS and counted in a new dioxane-based scintillation liquid. Reproducible and stable high-efficiency measurements were obtained. The method is superior to procedures reported so far with respect to reproducibility, efficiency, and economy. (auth)

31836 Th MICROANALYSIS USING FISSION TRACKS. Hair, M. W.; Kaufhold, J.; Maurette, M.; Walker, R. M. (Washington Univ., St. Louis). Radiat. Eff.; 7: 285-7(Feb 1971).

An improved method is described for Th determination based on the fission track production rates observed in sequential irradiations of an unknown with 30-MeV α particles and thermal neutrons. Measurements of U.S.G.S. standard powdered rock samples indicate an absolute accuracy of less than 10 per cent for concentrations greater than 0.1 ppm. This conclusion is verified by further comparisons based on specially fabricated trace Th glasses and certain natural obsidian samples. The technique also measures the U concentration of the unknowns. For obsidian artifacts and obsidian mine samples from the Aegean region, U–Th groupings were found that agree with previous groupings based on Ba and Zr analyses. The outstanding advantage of the fission track methods for Th determination is the ability to make absolute determinations on very tiny samples and to do micromapping of the Th distribution in larger samples. As an example, some of the powdered rock standards were found to be inhomogeneous on a microscale giving rise to sunburst patterns of fission tracks. (auth)

31837 DETERMINATION OF THE RADIOTHORIUM CONTENT OF MATERIALS BY THE DELAYED COINCIDENCE DECAY OF ^{220}Rn AND ^{216}Po ATOMS. Pomanskii, A. A.; Severnyi, S. A. At. Energ. (USSR): 29: 305-6(Oct 1970). (In Russian).

In order to be able to study the concentration of solar neutrinos, the ^{238}U, ^{226}Ra, ^{232}Th, and ^{228}Th content of the detectors used must be 4 to 5 orders of magnitude lower than the terrestrial concentration. On the basis of the authors' previously described method concerning the determination of very small amounts of ^{226}Ra, a highly sensitive method was developed to measure the concentration of the thorium family elements by counting the delayed coincidences between α particles from the decay of the inert gas ^{220}Rn and its daughter ^{216}Po. The Rn has a half-life of 54.5 sec, decaying with emission of 6.77-MeV α particles with a half-life of 0.58 sec. The content of ^{228}Th and its precursor may be determined by extracting the Rn atoms and recording their decay. In view of the relatively short half-life of Rn, the method used had to be able to record decay events of single Rn atoms with a short period of <1 min. The coincidence method, using 3-channel recording, allowed concentrations of 7×10^{-20} g of ^{228}Th (5×10^{-10} g of ^{232}Th) per ml of solution to be determined. The concentrations are listed for white spirit liquid scintillator, sodium iodide, perchloroethylene, water, and lithium chloride, which may be used as detector for solar neutrinos. (TTT)

31838 RADIOMETRIC METHOD FOR THE QUANTITATIVE DETERMINATION OF TERTIARY BUTYL ACETATE. Marton, A. F.; Dutka, F. (Central Research Inst. for Chemistry, Budapest). Radiochem. Radioanal. Lett.; 6: 185-8(3 Apr 1971).

A rapid and simple radiometric procedure for determining tert-butyl acetate by reaction with carbon-14-labeled acetyl chloride in nitromethane is described. The presence of primary and secondary alkyl acetates does not disturb the analysis. (auth)

31839 DETERMINATION OF URANIUM IMPURITIES IN GLASS BY COUNTING THE INDUCED FISSION TRACKS. Su, C. S. (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan): 7: No. 3-4, 8-16(Oct 1970).

The concentration of uranium impurities in glass was determined by counting the induced fission tracks of ^{235}U. Total track density changed linearly with the irradiation time of samples in the reactor. Average mass of uranium per unit volume was found to be $(1.02 \pm 0.14) \times 10^{-6}$ gm/cm^3 which corresponds to the uranium concentration ~0.4 ppM in weight in glass. (auth)

31840 IONIUM AND THORIUM BALANCE IN URANIUM MILLS. Dominguez, G. (Junta de Energia Nuclear, Madrid); Born, H.-J.; Lieser, K. H. Radiochim. Acta; 15: 128-32(Apr 1971).

A set of methods has been developed and applied to the assay of ^{230}Th and ^{232}Th in uranium ore samples and in process samples from uranium mills. With these data the distribution of both nuclides along the mill process is established and the more convenient point for an eventual ^{230}Th recovery is found to be the uranium-free ion exchange effluent. (auth)

31841 THE SIMULTANEOUS MEASUREMENT OF ^{51}Cr AND ^{14}C BY LIQUID SCINTILLATION COUNTING. Sheppard, G.; Marlow, C. G. (Radiochemical Centre, Amersham, Eng.). Int. J. Appl. Radiat. Isotop.; 22: 125-7 (Feb 1971).

In order to determine glomerular filtration rate, ^{51}Cr EDTA complex and hydroxymethyl ^{14}C in plasma and urine were assayed. It is demonstrated that ^{51}Cr and ^{14}C may be estimated simultaneously in the same sample by liquid scintillation counting and in addition that the ^{51}Cr may be assayed with much greater efficiency by this means than by the more normal sodium iodide crystal counting method. (UK)

31842 SIMPLE SEPARATION AND IDENTIFICATION OF RADIUM D, E, AND F. Glasoe, Paul K. (Wittenberg Univ., Springfield, Ohio). J. Chem. Educ.; 48: 268(Apr 1971).

Radium D (^{210}Pb), radium E (^{210}Bi), and radium F (^{210}Po) were separated by paper chromatography using butyl alcohol as a solvent. A strip of filter paper marked off in 1-cm sections was fitted to a hook on a stopper in a 500-ml Erlenmeyer flask with the paper barely touching the solution at the bottom. After about 1 hr when the solvent had progressed about $^{2}/_{3}$ the length of the strip the strip was removed, dried, cut up, and counted. The lead was found principally near the bottom of the strip and the bismuth near the top. Alpha counting revealed the polonium at the solvent front. (B.L.M.)

31843 RAPID AND SIMPLIFIED METHOD FOR LIQUID SCINTILLATION COUNTING OF RADIOACTIVE PROTEINS UTILIZING AQUASOL. Friedman, Marvin A.; Millar, Gail; McEvoy, Arthur; Epstein, Samuel S. (Harvard Medical School, Boston. New England Nuclear Corp., Boston). Anal. Chem.; 43: 780-1(May 1971).

The radioactivity observed with Aquasol is higher than with toluene/Priton x-100 scintillation solution. Samples prepared in Aquasol accurately indicate the protein activity, as shown by a linear response to protein concentration, and by a decrease in radioactivity of liver protein following treatment with cycloheximide and dimethylnitrosamine. Aquasol also has the advantage of forming gels when mixed with water. (D.P.O.)

31844 LIQUID SCINTILLATION COUNTING OF LOW LEVEL TRITIUM AS HYDROCARBONS. Perschke, H.; Florkowski, T. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isotop.; 21: 747-50(Dec 1970).

To obtain hydrocarbons that are miscible with the organic scintillator to measure tritium in a liquid scintillation counter, sample hydrogen can be incorporated quantitatively by reacting water with Grignard reagents. The probability was investigated of increasing the number of sample hydrogen atoms per molecule produced by hydrogenation of unsaturated hydrocarbons. Three unsaturated hydrocarbons were considered; diacetylene, vinylacetylene, and isopropenylacetylene. The first two yielded n-butane, the latter isopentane on hydrogenation. Isopropenylacetylene has the advantage of being commercially available. The preparation of diacetylene and vinylacetylene is described. The hydrogenation of all three acetylene hydrocarbons and the liquid scintillation counting procedure is discussed. The relative efficiencies of various tritium counting systems, including those proposed in this paper, are tabulated. (UK)

Activation Procedures

Refer also to abstracts 32074, 32088, and 32089.

31845 (GA–10142) FORENSIC NEUTRON ACTIVATION ANALYSIS OF PAINT. Schlesinger, H. L.; Lukens, H. R.; Bryan, D. E.; Guinn, V. P.; Hackleman, R. P. (Gulf General Atomic, Inc., San Diego, Calif.). 30 Jun 1970. Contract AT(04-3)-167. 261p. Dep. NTIS.

The characterization of paint samples was examined as a potential application of neutron activation analysis (NAA) in scientific crime detection. A variety of paints were analyzed by NAA, utilizing the purely instrumental procedure of neutron activation followed by gamma spectrometry and computerized data reduction, and 37 different elements were observed. The maximum number of elements quantitatively observed in any one paint was 25, and the average number observed in any one sample with modern gamma spectrometry techniques was 15. The work culminated in the examination of 155 different paints (some sampled in replicate) taken from the environment according to a stratified random sampling model derived from an environ-

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mental survey. Concentration distributions of the 15 most frequently observed elements, taken in the context of the degree to which replicate samples varied, were used to test various statistical models for interpretation purposes. Combinational statistics, which treats each element as an essentially independent variable, would satisfactorily explain the observed combinations of elemental concentrations in the 155 paints. Thus it was possible to predict, within the limits of distribution data provided by the data set, the probabilities of other combinations of concentrations and the probabilities of accidental matching of two different paint samples. As a result of this work the NAA method was shown to be an effective means of comparing paint specimens for forensic purposes. (auth)

31846 (KR-142) INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS OF ZIRCALOY USING A Ge(Li) DETECTOR. Steinnes, E. (Institutt for Atomenergi, Kjeller (Norway)). Feb 1971. 11p. Dep. NTIS (U. S. Sales Only).

The feasibility of instrumental neutron activation analysis with a Ge(Li) detector for determination of alloy constituents and trace elements in Zircaloy was studied. The following 17 elements were determined: Al, V, Cr, Mn, Fe, Co, Cu, As, In, Sn, Sb, La, Hf, Ta, W, Th, and U. The technique appears to be especially well suited for determination of Sn in % amounts, and for Al, V, Mn, Co, In, W, Hf, and U in trace concentrations. (auth)

31847 (NIM-987) RHYTHMIC-ACTIVATION ANALYSIS. Sellschop, J. P. F.; Uken, E.-A.; Steele, T. W. (National Inst. for Metallurgy, Johannesburg (South Africa)). 16 Jul 1970. 7p. Dep. NTIS (U. S. Sales Only).

A simple, loop sample-transfer system that should lead to the recognition, study, and determination of very short-lived isotopes by rhythmic neutron-activation analysis is described. (auth)

31848 (RCN-124) ROUTINE DETERMINATION OF ARSENIC IN BIOLOGICAL MATERIALS. Kroon, J. J.; Das, H. A. (Reactor Centrum Nederland, Petten). Aug 1970. 7p. Dep. NTIS (U. S. Sales Only).

A routine procedure for determination of arsenic in biological materials by neutron activation analysis is described. Unlike most published methods the analysis is not based on chemical separation by distillation. After a first purification by anion exchange the ^{76}As activity ($T_{1/2}$ = 26.4 h) is isolated by precipitation as the metal. The method was tested by analysis of standard kale powder. This material was prepared and issued by Bowen in 1966, to provide a reliable standard for the intercomparison of various methods. (auth)

31849 (RCN-136) TRACE-DETERMINATION OF CADMIUM BY NEUTRON ACTIVATION. APPLICATION TO AIR-BORNE PARTICULATES, HAIR AND FOODSTUFFS. Das, H. A.; de Vries, H. H. (Reactor Centrum Nederland, Petten). Feb 1971. 10p. Dep. NTIS (U. S. Sales Only).

A routine procedure by neutron activation for determination of cadmium in industrial air-borne particulate samples, collected on filter paper, hair, and foodstuffs is described. Cadmium is isolated by liquid–liquid extraction with a chloroform solution of dithizone. The activity of the ^{115}In daughter is counted. The method was tested by analysis of standard kale powder. (auth)

31850 SIMPLE, RAPID METHOD FOR DETERMINING TRACE MERCURY IN FISH VIA NEUTRON ACTIVATION ANALYSIS. Rottschafer, J. Mark (Univ. of Michigan, Ann Arbor); Jones, John D.; Mark, Harry B. Jr. Environ. Sci. Technol.; 5: 336-8 (Apr 1971).

A simple, rapid neutron activation method for mercury in fish tissue is described. The technique employs separation of the activated mercury as an $HgCl_4^{=}$ complex on an anion-exchange resin and direct counting of the resulting resin. Results showed that the analyses have a ±10% standard deviation for tissue samples containing mercury in the 0.05 to 10 ppM range, and the sensitivity has an approximate 3 ppB limit for the conditions employed. Example results for mercury content in different fish species from a variety of locations and different fish organs are given. Also, the results of replicate samples analyzed by a variety of different methods and in different laboratories are compared. (auth)

31851 USE OF NEUTRON ACTIVATION ANALYSIS IN DIAGNOSIS AND SUBSEQUENT CONTROL OF MORBUS WILSON. Henke, G.; Moellmann, H.; Althoff, W. (Univ., Muenster, Ger.). Klin. Wochensch.; 49: 284-6(1 Mar 1971). (In German).

The copper contents of liver punctates from a patient with Morbus Wilson were determined by neutron activation analysis before and after treatment with Penicillamine-D for several years. The results were compared with clinical findings and show that the determination of copper in liver permits more precise statements regarding both diagnosis and therapeutic success of Morbus Wilson. (auth)

31852 ACTIVATION ANALYSIS OF POLLUTED RIVER WATER. Mamuro, Tetsuo (Radiation Center of Osaka Prefecture); Matsuda, Yatsuka; Mizohata, Akira; Takeuchi, Takayuki; Fujita, Akira. Radioisotopes (Tokyo); 20: 111-16(Mar 1971). (In Japanese).

Instrumental neutron activation analysis by γ spectrometry with a high resolution Ge(Li) detector followed by spectrum analysis with an electronic computer was applied to elemental analysis of a river water sample from river water into which pour liquid wastes from a tungsten mine. The concentrations of 31 elements were determined, such as Cd, As, Sn and Cr. The presence of U was found by detecting ^{239}Np. Fluorescence x-ray analysis revealed the presence of Mo and Sr, but the concentrations of these two elements could not be determined by the present activation analysis. (auth)

31853 DETERMINATION OF OXYGEN IN GALLIUM PHOSPHIDE AND SILICON BY ^{3}He ACTIVATION. Kim, C. K. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Anal. Chim. Acta; 54: 407-14(May 1971).

A method is described for determining small concentrations of oxygen in single crystals of gallium phosphide; 14-MeV ^{3}He particles were used to convert ^{16}O into ^{18}F, which was then separated from other radioactive nuclides produced by bombardment of gallium. Coincidence counting of γ pairs produced by annihilation of emitted positrons was then used. Thin surface layers were removed from the crystals after irradiation to avoid interference from surface contamination and from recoiled oxygen nuclei driven into the lattice during bombardment. Results are reproducible and appear to be accurate to within 20%. Observed oxygen levels in gallium phosphide single crystals varied from about 5.10^{17} atoms cm^{-3} in specimens prepared by solution growth or halogen transport, to about 5.10^{18} atoms cm^{-3} in specimens prepared by wet hydrogen transport, 2.10^{-19} atoms cm^{-3} in oxygen-doped solution-grown crystals. Similar measurements are also reported for determination of oxygen in silicon single crystals. (auth)

31854 ACTIVATION ANALYSIS OF AIRBORNE DUST. Mamuro, Tetsuo (Radiation Center of Osaka Prefecture); Matsuda, Yatsuka; Mizohata, Akira; Takeuchi, Takayuki; Fujita, Akira. Radioisotopes (Tokyo); 20: 117-23(Mar 1971). (In Japanese).

Instrumental neutron activation analysis by γ spectrometry with a high resolution Ge(Li) detector followed by data processing with an electronic computer was applied to elemental analysis of airborne dust samples, which were collected at four stations selected in Osaka district, and atmospheric concentrations of more than thirty elements; Na, Al, Cl, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Zn, As, Se, Br, Rb, Ag, Cd, In, Sb, Cs, Ba, La, Ce, Sm, Eu, Yb, Lu, Hf, Ta, W, Au, Hg, and Th, were found to be determinable. Airborne dust was continuously collected on a membrane filter of 4.7-cm diameter and 1.2-μ pore size during a month, and average concentrations in the atmosphere in the month were determined. Descriptions are made on preparation of the dust specimens and the standard reference specimens for irradiation, the radionuclides and their γ energies, which were used for the determinations and examples of observational results. (auth)

31855 DETERMINATION OF OXYGEN IN ALUMINUM BY MEANS OF ACTIVATION-ANALYSIS USING 14 MeV-NEUTRONS. Schramel, P. (Gesellschaft fuer Strahlenforschung, Neuherberg, Ger.). pp 27-8 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

The determination of oxygen in aluminum by activation analysis is described. By bombarding ^{16}O with fast 14-MeV neutrons from an accelerator it is converted into ^{16}N. This emits high-energy γ radiation (6.13 or 7.13 MeV, half-life 7.35 sec). The only interference arises from the presence of fluorine which is also converted into ^{16}N by neutron bombardment. Work was accordingly carried out to develop a radiochemical process to separate the simultaneously formed ^{18}F (half-life 110 min) so that the activity of the fluorine could be measured independently. By this means high sensitivity and accuracy can be obtained. (auth)

31856 REMOVAL OF INORGANIC IONS FROM SOLUTIONS WITH ION-EXCHANGE CELLULOSE LOOSE FIBERS: CHECKING OF THE PURIFIED SUBSTANCES BY NEUTRON ACTIVATION

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ANALYSIS. Remporth-Horvath, Zs. (Eoetvoes Univ., Budapest); Oerdoegh, M. pp 105-9 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

Ion-exchange celluloses were used to remove heavy-metal impurities from large volumes of ethyl alcohol and distilled water. Concentrations of Cu(II), Fe(II), Pb(II), and Zn(II) ions were reduced to <1 ppB using a carboxymethyl cellulose loose fiber column. If Fe(III) was present as a contaminant, a mixed column also containing diethylaminoethyl cellulose was necessary. Neutron activation analysis was used to check the purity of the water after passing through the column. In the purified samples, the maximum concentrations of Cu was 7.5×10^{-2} ppB, Fe was <7 ppM, and Zn was $<7 \times 10^{-2}$ ppB. (B.L.M.)

31857 DITHIZONE AS A STATIONARY PHASE IN REVERSED-PHASE CHROMATOGRAPHY USED IN ACTIVATION ANALYSIS. Spevackova, V.; Krivanek, M. (Nuclear Research Inst., Rez, Czech.). pp 121-6 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

The use of dithizone as a chelate-forming agent adsorbed on a solid support was employed in a reversed-phase chromatographic process and was compared with liquid–liquid extraction to determine whether it was possible to apply extraction data to this separation method. ^{59}Fe and ^{60}Co were separated by the reversed-phase chromatographic method. Cu, Fe, and Zn were determined in mussels after neutron activation by the reversed-phase chromatographic separation method. The use of dithizone is limited to the alkaline range where it is soluble; however, in order to extend its range of use, metal dithizonates were adsorbed on the carrier. On the basis of extraction coefficients of various metals, group separations are possible by the choice of metal dithizonate adsorbed and by the choice of displacing metal. (B.L.M.)

31858 APPLICATION OF SOLVENT EXTRACTION IN THE DETERMINATION OF TRACE AMOUNTS OF NOBLE METALS BY RADIOACTIVATION ANALYSIS. Rakovskii, E. B.; Serebryani, B. L.; Rabinovich, B. S. (Lab. for Nuclear and Physico-Chemical Analysis, Moscow). pp 153-8 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

Gold was extracted as the complex $AuCl_4$ anion with cations of triphenylguanidine (TPG) in a solvent with a high dielectric constant, such as 1,2-dichloroethane. The extraction constant was $\sim 5 \times 10^5$. The effects of extraction time, HCl concentration of the aqueous phase, and various other elements on the extraction were investigated. On the basis of these investigations, a procedure was developed for the determination of Au in rocks by irradiation, extraction, and determination of the activity in the organic phase. Pt and Ir can also be determined radiometrically after an extraction of complexes. The dependence of extraction of Pt and Ir complexes with acetylacetone and 8-quinolinol on pH, reagent concentration, and time of heating and shaking was investigated. The results indicate that the Pt and Ir oxinates and acetylacetonates are extractable only at high temperature (>80°C) and offer a method of separation from metals that form extractable complexes at room temperature. Pt can also be extracted as the dithizone complex. (B.L.M.)

31859 GRAPHITE IRRADIATION CAPSULES FOR THERMAL NEUTRON ACTIVATION ANALYSIS. Coote, A. R.; Bewers, J. M.; Pearson, G. J. (Bedford Inst., Dartmouth, Nova Scotia). Radiochem. Radioanal. Lett.; 6: 265-74(24 Apr 1971).

The use of double-walled graphite irradiation capsules for nondestructive activation analysis is described. Impurity concentration and other characteristics of the graphite capsules are compared with conventional quartz vials. (auth)

31860 ANALYTICAL POSSIBILITIES OF REACTOR NEUTRON ACTIVATION METHOD IN NONDESTRUCTIVE ANALYSIS OF METEORITES. Vobecky, M. (Nuclear Research Inst., Rez, Czech.); Frana, J.; Randa, Z.; Benada, J.; Kuncir, J. Radiochem. Radioanal. Lett.; 6: 237-47(24 Apr 1971).

The analytical possibilities of nondestructive reactor activation analysis of meteorites are considered. The semiconductor, Ge(Li), spectrometry of γ radiation is employed for determining the short-lived and long-lived products of neutron activation. Results of analysis of various meteorite types are compared from the standpoint of the method application. Also, results of analysis of chondrites from Přibram and Police are presented. (auth)

31861 PURIFICATION OF ALUMINA BY THE ZONE MELTING METHOD AND ITS ANALYSIS BY ACTIVATION. Dhalenne, Guy; Rouchaud, Jean-Claude; Revel, Gilles; Revcolevscki, Alexandre (CNRS, Vitry-sur-Seine, France). Compt. Rend., Ser. C; 272: 538-40(8 Feb 1971). (In French).

Several zone melting passes were applied to a sintered alumina rod of commercial purity. The purification efficiency was determined in some ten elements by activation analysis. A very pure monocrystal is obtained with only two passages. (France)

31862 DETERMINATION OF THE OXYGEN CONTENT IN SILICON USING α PARTICLES. Giroux, Jacques; Talvat, Michel; Thomas, Jean-Paul, Tousset, Jean (Univ. Lyon, Villeurbanne, France). Bull. Soc. Chim. Fr.; No. 2, 706-12(Feb 1971). (In French).

Low oxygen contents in Si were determined by alpha activation using the Engelmann method. The effect of the beam energy distribution on the activation curves was investigated. The production profiles of ^{18}F and other radioisotopes were disturbed by complex phenomena appearing between 54 and 40 MeV. The formation of an oxide layer on the surface of the target was studied using microanalytical techniques. The diffusion of O and ^{18}F radioinduced on a Si surface does not explain the large amounts of these elements measured in the matrix. Because of the parasitic reactions in the matrix, the irradiation conditions were changed, the best energy range being about 35 MeV. The results of certain analyses are given. (France)

31863 ^{235}U ABUNDANCE DETERMINATION BASED ON ACTIVATION ANALYSIS. Bunus, F. T. (Inst. of Atomic Physics, Bucharest). Radiochim. Acta; 15: 118-22(Apr 1971).

An activation technique was used to determine uranium isotopic composition within the range 0.4 to 20% ^{235}U. This method, based on $^{239}Np/^{140}Ba$ ratio determination, is different of those previously mentioned in the literature by the following two alternatives selected: (1) $^{239}Np(VI)$ separation and a study of its behavior in TBP–kerosene was carried out. (2) ^{239}Np was directly estimated in the aqueous solution in the presence of fission products (FP) thus a simplification of the principle resulted. In both alternatives a barium (^{140}Ba) chemical separation was required. When ^{235}U sample contents were taken between 0.44 and 10.0% the average precision attained was 1 to 2% and this value might be improved if special precautions are observed. (auth)

31864 QUANTITATIVE DETERMINATION OF THYROID-HORMONE-IODINE IN BLOOD SERUM BY NEUTRON ACTIVATION ANALYSIS. Schmoelzer, G.; Mueller, K.; Spitzy, H. (Technische Hochschule, Graz). Int. J. Appl. Radiat. Isotop.; 21: 697-701(Dec 1970). (In German).

A quantitative determination of thyroid-hormone-iodine in blood serum by neutron activation is introduced. Separation of hormones from their protein carriers as well as from inorganic iodide and other coactivated serum constituents was achieved by chromatography on QAE-Sephadex A-25 columns. ^{128}I activity was induced by 10-min irradiation of the isolated hormones at a flux of 10^{13} n/cm^2/sec. Final isolation from still interfering components was again carried out by an anion exchange column before γ-spectrometric evaluation. Results are found to compare well with the chemical determination of thyroid-hormone-iodine. (auth) (UK)

31865 INTERPRETATION OF RESULTS OBTAINED BY ACTIVATION ANALYSIS. Smith, Hamilton (Univ. of Glasgow). J. Forensic Sci. Soc.; 9: 205-9(Dec 1969),

The interpretation of results with simple single element detection and results obtained from multi-element analysis are discussed. (D.P.O.)

31866 HAZARDS OF MERCURY. Special Report to the Secretary's Pesticide Advisory Committee, Department of Health, Education, and Welfare, November 1970. Environ. Res.; 4: No. 1, 1-69(Mar 1971).

The medical implications of ingestion of mercury, the microbial transformation of mercury, the sources, distribution, and control of mercury, ecologic effects of methylmercury contamination, the farming, food, and forestry uses of mercury, and airborne mercury are reported. Analytical methods for determining mercury include spectrophotometric determination of the dithizone complex, neutron activation, and atomic absorption. Gas chromatography is used for determining methylmercury and other organomercurials. Recommendations relating to major steps that should be taken to define and correct the problem of mercury pollution are given. (D.P.O.)

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31867 NON-HOMOGENEOUS BUT PARALLEL DISTRIBUTION OF ESSENTIAL TRACE ELEMENTS IN MULTIPLE ADJACENT SAMPLES OF SINGLE LIVERS, MEASURED BY NEUTRON ACTIVATION ANALYSIS. Schicha, H.; Feinendegen, L. E.; Kasperek, K.; Klein, H. J.; Siller, V. (Kernforschungsanlage, Juelich, Ger. Univ., Cologne). Beitr. Pathol.; 141: 227-32(1970).

The concentration of the essential elements Co, Fe, P, Se, and Zn, and of the nonessential element Sb was determined in various regions of liver tissue by neutron activation analysis. The nonessential as well as essential elements exhibit a wide range of variation throughout the liver. This mode of variation in successive samples is shared by Co, P, Fe, Se and Zn. It is assumed that the specific variation of related groups of trace elements expresses changes of nucleic acid and protein synthesis in different liver regions. Analyses of trace elements from single liver samples are not representative of the whole liver. (auth)

31868 NON-DESTRUCTIVE DETERMINATION OF FLUORINE WITH Be–D NEUTRON ACTIVATION ANALYSIS USING GOLD AS INTERNAL STANDARD. Jinno, Kiyokatsu; Yoshikawa, Mamoru; Ishii, Daido (Nagoya Univ., Japan). Kogyo Kagaku Zasshi; 74: 164-7(Feb 1971). (In Japanese).

A method for determination of fluorine based on the short half-life isotope ^{16}N, produced by the reaction $^{19}F(n,\alpha)^{16}N$, was investigated. The advantage of this reaction is the high energy of the γ radiation, which enables most interferences to be eliminated. Interferences due to the reaction $^{16}O(n,p)^{16}N$ can be avoided by using Be–D neutrons of energy below the threshold for the (n,p) reaction on ^{16}O. To avoid the lowering in precision due to change in the analytical condition, especially neutron flux, gold was used as an internal standard material. Since ^{197m}Au produced by the reaction $^{197}Au(n,n_i)^{197m}Au$ has similar half-life to ^{16}N, the activity of the latter is conveniently normalized by that of the former. As a result, a straight line was obtained as the calibration curve for the fluorine determination with relative mean error of 2.1% for 60 to 800 mg of fluorine. (auth) (Japan)

31869 NEUTRON ACTIVATION ANALYSIS OF INDUSTRIAL PRODUCTS. 2. ANTIMONY LEVEL IN BULLET LEADS. Isono, Hideo (National Research Inst. of Police Science, Tokyo); Tsunoda, Noriko; Kozuka, Hiroshi; Niwase, Takeshi. Kagaku Keisatsu Kenkyusho Hokoku; 23: 247-52(Sep 1970). (In Japanese).

Thirty-four kinds of bullets differing in appearance and manufacture were prepared, and three bullets were chosen from each box as samples. About ten mg of lead obtained by drilling each bullet from the bottom was used for irradiation in the core of HTR nuclear reactor having a thermal neutron flux of $2.1 \times 10^{12} n/cm^2/sec$ for five hr. The Sb levels of about 80% of the samples were found to lie in the range 5×10^3 to 3×10^4 ppM. Considerable differences were shown even in the Sb content of samples of each class, even though the three from the same box appeared quite uniform with a few exceptions. Cu and Ag could also be determined in the samples with a low Sb level. (auth) (Japan)

31870 ON-LINE COMPUTER SYSTEM FOR INSTRUMENTAL ACTIVATION ANALYSIS OF AIR, WATER, AND SOIL. Salmon, L.; Creevy, M. G. (Atomic Energy Research Establishment, Harwell, Eng.). pp 47-61 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A computer system is described that simultaneously accumulates gamma spectra from several detectors, performs appropriate data transfers, and carries out numerical analyses. A twelve thousand word store is used supported by a mega-word disc. Routine analyses are performed on short-lived nuclides with a sodium iodide detector whilst longer-lived material is measured with germanium (lithium) detectors. (auth)

31871 NEUTRON ACTIVATION ANALYSIS OF TRACE ELEMENTS IN AIRBORNE PARTICULATES. Tuttle, R. F.; Vogt, J. R.; Parkinson, T. F. (Missouri Univ., Columbia). pp 119-37 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Thermal neutron activation was used to analyze airborne particulates collected on Millepore WS paper from a heavily industrialized area (Cincinnati, Ohio) and (using Millipore EH filters) from a nonindustrialized community (Columbia, Missouri). The method utilized nondestructive instrumental techniques with computer analysis of the data. Elemental concentrations for the Cincinnati samples are given as follows (concentrations for each element are minimum, average and maximum values in $\mu g \cdot m^{-3}$, respectively): Al–0.61, 0.99, 3.10; As–0.007, 0.03, 0.05; Br–0.034, 0.10, 0.16; Ca–0.32, 2.07, 7.20; Cl–0.24, 0.90, 3.00; Cu–0.05, 0.28, 0.67; Mg–0.03, 0.054, 0.07; Mn–0.16, 0.39, 0.52; Na–0.16, 0.54, 0.76; Sn–0.012, 0.025, 0.036; V–0.002, 0.023, 0.048. The presence of As, Ca, Mg, and Sn has not been observed previously by other investigators using the instrumental neutron activation technique. For the samples collected in Columbia, Missouri, only Al, Br, Cl, Ca, Mn, Na and V were observed. The concentrations of Al, Br, and Cl were similar to the values observed for the Cincinnati samples. A survey of ten different commercially available filter materials was made. (auth)

31872 QUANTITATIVE RELATIONSHIPS AMONG TRACE ELEMENTS OVER INDUSTRIALIZED N. W. INDIANA. Dams, R. (Inst. of Nuclear Sciences, Ghent); Robbins, J. A; Rahn, K. A.; Winchester, J. W. pp 139-57 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A series of 25 simultaneous air-filter samples taken over the heavily industrialized area of Northwest Indiana, USA, and nearby rural locations was analyzed for 30 trace elements by nondestructive neutron activation analysis. From the concentration isopleths and coefficients of variance it appears that, while some elements show only minor variations over the area, others show marked concentration increases near large industrial complexes, indicative of important local pollution sources. These trends are also reflected in similarities or differences between geometric mean concentrations over the central industrial versus surrounding areas. The particulate composition is found to be in close agreement with an earlier emissions inventory of the area. Ratios of rare earths, calcium/magnesium, and selenium/sulphur appear to be in agreement with those of their suspected sources, namely clay minerals, dolomite and combustion of fuels. A strong relationship between several elements likely to have common sources is demonstrated by linear correlation coefficients, mathematical cluster analysis, and point regression techniques. Pollution elements such as Fe, Mn, Zn, Sb, Cr, W, Co, Sc, La, Ce, Th, Ca, and Mg seem to be linked strongly to the local steel production and supporting industries. Cu, though also apparently of industrial origin, has a different major source location. The elements Na, K, Sm and Eu, all having low coefficients of variation, are grouped together by the cluster analysis and appear to have sources not unique to industrial areas. (auth)

31873 USE OF ACTIVATION ANALYSIS TO DETERMINE THE CHEMICAL COMPOSITION AND ORIGIN OF PARTICULATES COLLECTED IN THE MARINE ATMOSPHERE. Wilkniss, P. E.; Larson, R. E. (Naval Research Lab., Washington, D. C.). pp 159-68 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The use of neutron activation, photon activation, and proton activation analysis to determine the elements B, F, Na, S, Cl, K, Ca, Mn, Br, Sr, and I in particulate samples from the marine atmosphere was investigated. Methods were developed for collecting airborne particulates on ships and aircraft and at shore stations. Appropriate sample preparation procedures were developed for the different types of activation analysis. Environmental samples were obtained by aircraft flying at low altitudes 50 miles off the eastern coast of the USA, on a ship during an Atlantic crossing from the Caribbean to the Mediterranean Sea, and at a shore station on the island of Hawaii. Activation analysis of the aerosol samples was shown to be an excellent method for determining the listed elements. The implication for pollution studies is that, by determining elemental ratios such as F/Cl, Na/Cl, Na/K, Ca/S and Mn/Cl, the origin, natural (the ocean, or volcanic activity) or man-made, can be determined. Samples taken along the Atlantic coast of the USA show the influence of polluted continental air masses in near-shore regions; influx of African dust was found in the middle of the Atlantic and "pure" marine aerosols were analysed in Hawaii. (auth)

31874 RADIOACTIVATION ANALYSIS FOR THE DETERMINATION OF TRACE ELEMENTS IN AIR POLLUTANTS. Bando, S. (Japan Atomic Energy Research Inst.; Tokyo); Yamane, Y.; Murakami, Y. pp 169-81 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the mea-

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surement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Radioactivation was applied to determine trace quantities of aluminum, manganese, and vanadium, representing the short-lived nuclides, and of scandium, chromium, iron, cobalt, zinc, and antimony from among the long-lived nuclides. These metals were selected mainly on the basis of the position of their photoelectric peaks in the gamma spectra. The destructive and the nondestructive methods are compared, with satisfactory results. For the latter, a chemical separation method applying anion exchange resins was tested. To avoid serious interference by zinc in the gamma spectrometry determination, a correction method was proposed. It was found that if the interference due to the presence of zinc is not less than 400 times that of scandium, it presents no problem. A Ge(Li) detector made it possible to determine aluminum and vanadium by the nondestructive method, while the use of an NaI detector made it possible to determine vanadium in the presence of a larger amount of aluminum after its separation in the form of a 2-methyloxine complex. Samples were collected at the rate of one a month from September 1966 in the Keiyo industrial area (Chiba Prefecture) just East of Tokyo. Deposit gauges were placed at various points and sample containers were collected each month. The contents of the container were filtered and then dried at 100°C, and tarry matter was removed by extraction in a Soxhlet extractor. For suspended particulate matter in air, a Millipore filter was provided in an air sampler; the sampler was suctioned for two hours or continuously for two weeks to collect the sample. Lower detection limits obtained as follows: Zn $-2 \times 10^{-2}\mu g$, Sb $-2 \times 10^{-2}\mu g$, Sc $-2 \times 10^{-4}\mu g$, Fe $-3.5\mu g$, Co $-5 \times 10^{-3}\mu g$, and Cr $-5 \times 10^{-2}\mu g$. (auth)

31875 ISOTOPE SEPARATOR AS A TOOL FOR LOW-LEVEL RADIOASSAY AND TRACE ACTIVATION ANALYSIS. Currie, L. A.; De Voe, J. R. (National Bureau of Standards, Washington, D. C.). pp 183-90 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Determinations of environmental radioactivity and of low-level products of nuclear activation are frequently limited in sensitivity because of isotopic contamination. Sensitivity may be limited by radioisotopes because of interfering radiations and by stable isotopes because of decreased specific activity. To overcome these limitations, electromagnetic isotope separation, which is applicable to most elements, was investigated as a complement to radiochemical separation and decay scheme resolution. The characteristics of the relatively new class of laboratory isotope separators having moderately large beam currents, 1 to 5 mA, are particularly suitable, for they include reasonable throughput (~mg/h), yield(~10%) and resolution (~10^3). Isotope separation was investigated in connection with the neutron activation analysis of trace quantities (~10^9 atoms) of iodine. The mass-separation step was to be essential because of the production of interfering iodine fission products, even when uranium contamination was as low as 1 ppM. A particularly important result of the investigation was the absence of any detectable blank effect from prior separations. In addition, it was found that for certain problems electromagnetic separation, when combined with a high efficiency radiation detector, is far more sensitive and selective than a high resolution detector without mass separation. (auth)

31876 SEMI-AUTOMATIC METHOD OF NEUTRON ACTIVATION ANALYSIS WITH APPLICATION TO ENVIRONMENTAL STUDIES. Edgington, D. N.; Lucas, H. F. Jr. (Argonne National Lab., Ill.). pp 311-22 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A semi-automatic system for the analysis of a wide range of biological and environmental samples was developed and evaluated. Interference from major components (i.e. ^{24}Na, ^{32}P, and ^{42}K) produced in these samples by neutron activation is eliminated by ion-exchange methods. This permits the accurate determination of many trace elements of importance in environmental pollution. The irradiated samples are dissolved in strong acid and separated into fractions containing one or more elements by anion exchange chromatography. The gamma-ray spectrum of each fraction is then obtained using a NaI(Tl) detector. The output from the multichannel analyser is recorded directly onto computer-compatible magnetic tape. The individual spectra are then fitted by the computer using an iterative, weighted, least squares method. After the dissolution of the sample, the chemical separations are semi-automated and require a minimum of operator assistance. The counting system is completely automated and adjusts the counting period for each sample according to its count rate. For environmental studies where it is necessary to analyse a large number of samples, this system of analysis using NaI(Tl) detectors has been shown to be superior to that of using minimal chemical separations and Ge(Li) detectors as far shorter counting periods are required to attain a comparable sensitivity. The sensitivity of the least squares method approaches the limit imposed by the statistical accuracy of the data and the standard spectra available. Minor components of the complex gamma spectrum were resolved and proven to be present at levels as low as 0.5% of the integral count rate. To achieve the same sensitivity for the same samples using a 22-cm^3 Ge(Li) detector and the peak-area evaluation technique, careful statistical studies have shown that the counting interval must be fifty to two hundred times greater than that using an 8 × 8-cm NaI(Tl) detector. The concentrations of seventeen trace elements were determined in fish from Lakes Erie, Michigan, and Superior. The contents of several trace elements were found to vary with species and collection site, with cadmium, arsenic and chromium having the greatest variability. A preliminary investigation was made of the sediments collected in Green Bay where there is a sharp boundary between nonpolluted and polluted areas. The results point to a marked difference in trace element distributions between the two areas. (auth)

31877 COMPREHENSIVE PROGRAM IN NEUTRON ACTIVATION ANALYSIS IN WATER QUALITY. Thatcher, L. L.; Johnson, J. O. (Geological Survey, Denver). pp 323-8 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A comprehensive scheme of water analysis based on application of selected irradiation and decay times, simple group chemical separations, and gamma-spectroscopy with Ge(Li) detectors is being developed at the US Geological Survey Nuclear Center. Vanadium, aluminum, and manganese are determined with five-minute irradiation that does not excessively activate sodium. Mercury is determined by activation for four hours, precipitation with carrier mercury and stannous chloride followed by counting of the ^{197}Hg gamma and gold x-ray. Both energy peaks are resolved for the most certain identification. Arsenic and other polluting elements are determined after sulfide coprecipitation to separate them from sodium-24 and other interfering activities. Research on the determination of selenium and tellurium is in progress. (auth)

31878 NEUTRON ACTIVATION ANALYSIS OF THE AQUATIC ENVIRONMENT IN THE DANUBE. Draskovic, R.; Tasovac, T.; Radosavljevic, R. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). pp 329-34 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

As part of a program for studying physical, chemical, and biotic processes in the Danube, which, as an international river, has become increasingly polluted, determinations of trace elements in water, suspended material and bed sediments were made by neutron activation and gamma-spectrometry with a Ge(Li) detector. Gamma spectra of irradiated samples of bed and suspended materials are given. Cr, Fe, Co, Sc, Sb, and La were determined in suspended material and water. (J.G.B.)

31879 TRACE-ELEMENT CHARACTERIZATION OF CRUDE OILS AND FUEL OILS VIA INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Guinn, V. P.; Bryan, D. E.; Lukens, H. R. (Gulf General Atomic, San Diego, Calif.). pp 347-59 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A method of comparing oil-slick samples with samples of crude oils and residual (bunker) fuel oils of known origins is under development. The method involves application of the principle of trace-element characterization, widely used in forensic studies, using multi-element compositional data obtained via instrumental Ge(Li) detector for thermal-neutron activation analysis of oil samples. Twenty different crude oils and 20 different residual (bunker) oils, from many parts of the world, were analysed. A total of 22 elements was detected and measured quantitatively in these samples, although in any one sample, the number of elements found ranges from 6 to 17 (under the irradiation and

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gamma-ray spectrometry conditions employed.) The 22 elements found are: Na, Al, S, Cl, V, Mn, Co, Ni, Ga, As, Br, Sr, Mo, Zn, In, Sn, Sb, I, Ba, La, Sm, and Au. If an element could not be detected in a sample, a firm concentration upper limit was calculated from the data. In general the concentration of any particular element was quite reproducible in oil specimens of a given origin, but ranged widely amongst samples of different origins. For example, in the 20 crude oil samples the vanadium concentrations ranged from as low as less than 0.02 ppM to as high as 136 ppM (with a median of 9 ppM), a range of more than 6800-fold. Experiments established that extended agitation of such oil samples (up to 48 hours) with either fresh water or seawater does not appreciably alter the concentrations of more than a few of the various trace elements present. On oil samples in contact with water the effects of temperature, ultra-violet radiation and bacteria were also explored. Further studies are in progress to develop the method to the stage of practical water-pollution law-enforcement application (i.e. so as to be able to ascertain which ship, offshore well or fuelling/loading station in the area generated a particular oil slick). Simultaneously, trace-element information of much marine biological and geochemical interest is being obtained. (auth)

31880 ACTIVATION ANALYSIS OF MERCURY AND OTHER ENVIRONMENTAL POLLUTANTS IN WATER AND AQUATIC ECOSYSTEMS. Ljunggren, K. (Isotopes Techniques Lab., Stockholm); Sjoestrand, B.; Johnels, A. G.; (and others). pp 373-405 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

With the recognition of mercury as a widely occurring environmental pollutant, activation analysis was brought into use in Sweden on a large scale to establish concentration levels in the environment and to locate contaminated zones, to reveal the sources of mercury contamination and to study the transport of mercury in nature and its enrichment through the food chains of exposed ecosystems, particularly in the aquatic environment. The analytical method used is referred to and the results of studies of the aquatic environment in Sweden are outlined. Recently, arsenic and cadmium have also come into focus as water pollutants and analytical procedures using activation techniques have been developed. A short description of the methods is given together with a presentation of preliminary studies on the arsenic content of fish, such as herring and cod, and on the cadmium content of fresh-water organisms (plants, invertebrates, fish). (94 references) (auth)

31881 NEUTRON ACTIVATION STUDY OF ENVIRONMENTAL CONTAMINATION AND DISTRIBUTION OF MERCURY IN ANIMALS AND FISH. Byrne, A. R.; Dermelj, M.; Kosta, L. (Jozef Stefan Inst., Ljubljana, Yugoslavia). pp 415-27 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The uptake and distribution of mercury in the biosphere around the mercury mine and distillation plant at Idrija, Slovenia, Yugoslavia, was studied as a contribution towards establishing tolerance levels and the possibility of the adaptation of living organisms to its increased concentration. A brief description of the general situation around the works is given. Two sampling sites were chosen, one near the main discharge point for the flue gases of the distillation plant, i.e., in an area contaminated with finely dispersed elemental mercury, and the second in an area where ore deposits (cinnabar) occur on or near the surface. The neutron activation method used to determine the mercury content of samples, which lie between 0.1 and 500 $\mu g/g$, is described. The sampling and, where appropriate, washing techniques are also given. The initial samples consisted of excreta as well as of the fur, feathers and hair of rabbits, hens and cows. Hens' eggs and cows' milk were also analysed at different periods of the year. In another set of experiments rabbits were taken, one from each of the sampling areas, to an uncontaminated area and the mercury content of the blood and excreta followed for 50 days. Residual mercury in various organs was finally determined and compared with rabbits from the original area analysed immediately. The mercury content of various organs of hens taken from the two areas was also determined. Trout were taken from the river above, and at two sites below the point where residue deposits from the mercury mine come into contact with the river water. Analysis of various organs, flesh, and roe showed that apparently healthy fish below the contact point accumulate very large quantities of mercury. Finally comparison is made with work previously published on the content and accumulation of mercury in animals including fish and some tentative conclusions are drawn on the possible ability of certain species to accommodate to considerably increased levels. (auth)

31882 STUDY OF MERCURY AND IODINE DISTRIBUTION IN NORWEGIAN FOREST SOILS BY NEUTRON ACTIVATION ANALYSIS. Lag, J. (Agricultural Coll. of Norway, Vollebekk); Steinnes, E. pp 429-38 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The distribution of mercury and iodine in forest soils was studied. Simple and specific radiochemical neutron activation methods for the determination of these elements in humus samples were developed. This work is part of a large-scale investigation of Norwegian forest soils, the material of which has previously been analysed for many macro-constituents and for a number of trace elements. The results obtained for mercury so far do not show high regional variation. The concentration of iodine, on the other hand, seems to decrease with increasing distance from the sea, a fact which is probably associated with differences in the precipitation. (auth)

31883 TRENDS IN THE CONCENTRATION OF HEAVY METALS IN ORGANISM OF A MESOTROPHIC LAKE AS DETERMINED BY ACTIVATION ANALYSIS. Merlini, Margaret; Bigliocca, Carla; Berg, A.; Pozzi, G. (Divisions of Biology and Nuclear Chemistry, Ispra, Italy). pp 447-58 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A study was undertaken to establish levels of Zn, Mn, Fe, Co, and Cu by means of activation analysis in parts of edible fish from Lake Maggiore, Northern Italy, and in some species of plants. The collections were made four times a year, taking into account seasonal variations and the concomitant physiological changes in the fish. Details of the analytical techniques and the results obtained are presented and discussed. (auth)

31884 NUCLEAR ANALYTICAL METHODS AND SYSTEMS FOR THE MEASUREMENT OF TRACE CONSTITUENTS IN THE ENVIRONMENT. Wainerdi, R. R.; Fite, L. E.; Kuykendall, W. E. (Texas A and M Univ., College Station). pp 459-80 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Limitations and capabilities of available nuclear methods, including activation analysis, isotope dilution, and radiation reflection are discussed. Activation methods are of particular interest in pollution control. Many materials of known toxicity, such as Hg, As, Br, and Pb, lend themselves to microanalysis using neutron, charged particle, or photonuclear activation analysis. The sensitivity of activation methods finds use in early warning situations before clinical or other symptoms develop. It is to be expected that other elements will be measured and monitored in the environment both in terms of absolute levels and in the rate of change of such levels using combinations of nuclear and nonnuclear microanalytical techniques as part of an expanding world-wide program of environmental quality preservation. (81 references) (J.G.B.)

31885 NEUTRON ACTIVATION ANALYSIS IN THE DETECTION OF POLLUTANT ELEMENTS RETAINED BY PLANTS: APPLICATION TO ELEMENTS TAKEN UP FROM PESTICIDES AND INDUSTRIAL FUMES. Fourcy, A.; Fer, A.; Garrec, J.-P.; Nueburger, M. (Centre d'Etudes Nucleaires, Grenoble, France). pp 507-19 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Two methods of radioactivation analysis were used. One is based on thermal neutrons from a reactor and enables analyses to be made of elements such as Mn, Cu, Zn, Br, and As (in addition to the series of stable elements corresponding to the fission products Ba, Cs, Sr, Ru, etc.). The other method makes use of 14-MeV fast neutrons from a generator and is particularly effective in the detection of fluorine in polluted environments. Leaf and fruit samples are collected with the normal precautions in the polluted zone and delivered in sealed bags to

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the laboratory, where they are furnace-dried and reduced to powder. In the case of Cu, Zn, Br, and As trace analysis entails rapid and specific radiochemical separation followed by high-sensitivity counting with a sodium iodide detector. The method can be used for the residues of pesticides such as Bordeaux mixtures, organic fungicides based on zinc and manganese thiocarbonates, arsenic-containing insecticides and bromine-containing derivatives, which are widely employed in fruit growing and viticulture. The sensitivity of the method is such that one can carry out analyses on parts of fresh fruit or on products of the food industry. Systematic analyses of fluorine and investigation of the migration of this element in plants have become increasingly important since it was discovered that vast areas of cultivation and forest near aluminum plants are being gradually destroyed. It is becoming possible to draw maps showing the fluorine concentration in different annual or perennial plant species and to determine the areas most affected. (auth)

31886 WATER POLLUTION STUDIES BY MEANS OF INACTIVE INDIUM TRACER AND ACTIVATION ANALYSIS. Dahl, J. B.; Haagensem, U. H.; Thomassen, J.; Tollan, O. (Institutt for Atomenergi, Kjeller, Norway). pp 663-72 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

An inactive tracer combined with activation analysis was used to study in detail the water stream pattern and dilution factors in and around the harbor of a Norwegian town. The work was carried out in connection with the planning of a new main sewer outlet. Indium was chosen as inactive tracer because of the extremely high sensitivity of activation analysis to this element, and its low concentration in nature. A solution of indium nitrate was added continuously to the water by means of a special device submerged to the actual water depth at the point of the planned sewage discharge. By adding the indium tracer solution over a period of three days, a condition of nearly constant indium concentration in the actual areas was established, thus facilitating an easy way of determining the dilution factors. Samples of about one litre were collected from different depths at as many points as practical. The trace amount of indium was separated from the water samples by a simple coprecipitation technique, and neutron activation was then carried out. Details of the procedures and results from an actual investigation are given. The method is very sensitive, and offers the possibility of measuring selectively the distribution of pollutants at long distances from particular sewer outlets. The expected distribution of pollutants from planned outlets may be measured in the same way by simulating a discharge under various conditions. (auth)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 32234, 32640, and 32642.

31887 SYNTHESIS AND PROPERTIES OF TWO SERIES OF HEAVY METAL HEXACYANOFERRATES. Ayers, Jerry B. (Univ. of Georgia, Athens). J. Inorg. Nucl. Chem.; 33: 721-33 (Mar 1971).

Two series of metallic (including uranyl) hexacyanoferrate salts were prepared and their ir, visible and uv spectra investigated in the solid state using potassium bromide as the carrier medium. The ir spectra also were investigated using the mull technique. The spectral data are discussed and transition assignments for the observed absorption bands are suggested. X-ray diffraction data are reported for the compounds. (auth) (UK)

31888 CHEMICAL INSTITUTE OF CANADA AND AMERICAN CHEMICAL SOCIETY JOINT CONFERENCE, TORONTO, MAY 24-29, 1970. ABSTRACTS OF PAPERS. Washington, D. C.; Special Issues Sales, American Chemical Society (1970). 233p. $4.00. (CONF-700561-(Absts.)).

Chemical Properties

Refer also to abstracts 31980, 32042, 32066, and 32445.

31889 (KFK-1325) SEVERAL INVESTIGATIONS OF HIGH-PRESSURE FLUORINATION OF BINARY AND TERNARY FLUORIDES OF SEVERAL LANTHANIDE AND ACTINIDE ELEMENTS. Haug, H. O.; Hansmann, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Feb 1971. 23p. (In German). Dep. NTIS (U. S. Sales Only).

Terbium tetrafluoride was prepared in a fluorine gas stream and at high fluorine pressure. With praseodymium trifluoride, however, no reaction occurred even at 350 atm of fluorine. Thermogravimetric analysis (TGA) of TbF_4 in a vacuum showed a decomposition even at room temperature, which increased with heating to about 330°C. A rapid decomposition followed between 370 and 500°C. In the series of fluoro-complexes of hexavalent actinides the compounds $NaUF_7$ and Na_2UF_8 were investigated by TGA and x-ray diffraction. The decomposition of $NaUF_7$ in vacuum occurred by liberation of UF_6 in two steps. Na_2UF_8 was formed between 60 and 145°C, and NaF between 150 and 240°C. The residue also contained small amounts of U(V) and U(IV), which indicates the minor but simultaneous liberation of fluorine during the second part of the decomposition. (auth)

31890 (MLM-1807) PLUTONIUM DISPROPORTIONATION REACTIONS: SOME UNRESOLVED PROBLEMS. Silver, G. L. (Mound Lab., Miamisburg, Ohio). 10 May 1971. Contract AT-(33-1)-Gen-53. 56p. Dep. NTIS.

The preparation of a predominance region diagram for aqueous plutonium solutions is discussed, and conditions for the equality of the concentrations of three plutonium species are suggested. Other methods of determining the values of variable stoichiometry coefficients for tetravalent and pentavalent plutonium are proposed, as are methods for ascertaining plutonium valence state distributions in dilute acids without recourse to lengthy analytical procedures. These methods involve measurement of two solution variables such as acidity and redox potential or fraction of one plutonium species, and are illustrated with computer programs by Carl Wendling. A method of ascertaining the acidity of maximum stability of pentavalent plutonium is proposed, and the effect of temperature upon the stability of the pentavalent plutonium ion is suggested. (auth)

31891 (NIM-1031) THE DISSOLUTION OF UO_2 AS AN ELECTRON-TRANSFER REACTION. Laxen, P. A. (National Inst. for Metallurgy, Johannesburg (South Africa)). 16 Sep 1970. 12p. Dep. NTIS (U. S. Sales Only).

Factors affecting the dissolution of single crystals in acid solutions containing ferric ions were studied. Single crystals of high-purity uranium dioxide were mounted in briquettes, which were then placed in an enclosed reaction vessel to which solutions were added at a constant temperature of 35°C. The effect of the following on the dissolution of uranium was studied: chloride, nitrate, and sulfate additions; perchlorate media at different pH values; and the concentration of ferric and ferrous ions. It was concluded that the dissolution of uranium dioxide by ferric ions is a redox reaction similar to many other related electron-transfer reactions. Activation energies of between 15.5 and 16.1 kcal/mole were obtained. (auth)

31892 (RFP-Trans-77) AMMONIATES AND AMMONOLYSIS OF URANIUM TRICHLORIDE. Berthold, H. J.; Knecht, H. Translated for Dow Chemical Co., Golden Colo., from Z. Anorg. Allg. Chem.; 356: 151-62(1968). 19p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 50979.

31893 CHEMICAL STUDIES DESIGNED TO PREPARE RADIOPROTECTIVE AGENTS. Muhi-Eldeen, Zuhair A. R. Columbus, Ohio; Ohio State Univ. (1970). 97p. University Microfilms Order No. 70-26,336.

Thesis.

The observation that γ-mercaptopropylamine (MPA) is two and one-half times as effective as β-mercaptoethylamine (MEA) in protecting animals against ionizing radiation was interpreted on the basis of the greater ability of γ-mercaptopropylamine to trap free radicals by forming a more stable six-membered ring intermediate. This intermediate would enable delocalization of the odd electron over three atoms; β-mercaptoethylamine may form a less favorable five-membered ring intermediate in order to obtain the same delocalization. The mechanism was further studied by the synthesis of two sets of compounds, the design of which was based on either electronic or stereochemical considerations. (A) The electronic approach to the design of radioprotective agents. α-Amino-N-phenylmonothiosuccinimide and α-amino-N-phenyldithiosuccinimide are compounds containing a basic amino group, which is located 2 or 3 carbons from an S-atom. Unlike the situation for MEA and MPA, the sulfur atom in these systems is in a form of C=S group rather than in the form of SH group. It seemed likely that thionimides would readily act as free radical trapping agents and their synthesis was investigated. L-(S)-aspartic acid served as starting material and was utilized to investigate routes applicable to the synthesis of α-amino-N-phe-

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nylsuccinimide of known absolute configuration. Various functional groups such as the benzyloxycarbonyl group (cbz), t-butyloxycarbonyl group (BOC) trityl and acetyl groups were investigated in the synthesis. α-Amino group protection utilizing the t-butyloxycarbonyl function proved most applicable to the synthesis of the desired L-α-amino-N-phenylsuccinimide hydrochloride. The five-step synthesis to the α-amino-N-phenylsuccinimide hydrochloride having the known L-(S) absolute configuration involves reaction of L-aspartic acid with some protecting group Z, followed by anhydride formation, reaction with aniline to form the anilide, and subsequent ring closer affording the imide. Hydrolysis under mild acid conditions yielded optically pure L-(S)-α-amino-N-phenylsuccinimide. However, all attempts to convert this compound to the desired thionimide were not successful. The five-step sequence of reactions involving the described protecting group was studied utilizing optical rotatory dispersion as a means of detecting racemization. The sign of the Cotton effect for various intermediates in the synthesis of the final imide was correlated with the absolute configuration of the asymmetric center. Nmr analysis of the ABX type for alicyclic protons of the imide ring was discussed. In all cases Nmr analysis of the relatively flat heterocyclic ring showed cis-coupling (8.74 to 11.90 Hz) to be larger than trans-coupling (4.74 to 6.79 Hz). As expected, the geminal coupling for the extended π-system was larger than either cis- or trans-coupling. Introduction of a trityl group on the α-amino nitrogen rendered the ABX spectrum deceptively simple. (B) The sterochemical approach to the design of radioprotective agents. The isomers cis- and trans-1-amino-2-methylmercaptocyclopropane are related to the respective eclipsed and staggered conformations of MPA. For purposes of investigating stereochemical requirements for radiation protection activity, studies directed toward the synthesis of these stereoisomers were initiated. Previous studies in our laboratories suggested the tetrahydropyranyl ring to represent satisfactory protecting group for the SH function. Reaction of 2-allylthiotetrahydropyran with ethyl diazoacetate afforded a mixture of cis- and trans-2-(2′-tetrahydropyranylthio) methyl-1-carboethoxycyclopropane as well as a Stevens rearrangement product. Conditions are described which favor the production of a trans- to cis-ratio of 83 to 17% cyclopropane with little Stevens rearrangement product. These isomers, which could not be separated by physical methods, were converted to the hydrazide and via the Curtius rearrangement converted to the intermediate isocyanates. The isocyanate was readily converted to the corresponding amine having a similar isomeric ratio as starting ester. (Diss. Abstr. Int., B)

31894 REACTIONS OF URANIUM TETRACHLORIDE WITH ORGANIC ESTERS. Bhandari, A. M.; Dubey, S.; Kapoor, R. N. (Univ. of Jodhpur, India). J. Prakt. Chem.; 311: 1013-17(1969).

Uranium tetraacetate is always the end product when uranium tetrachloride is treated with excess of tertiary butyl acetate, even in cold. However, when uranium tetrachloride is made to react with other esters, the replacement of chloride groups by acetate groups was found to be in the order normal < secondary < tertiary, resulting in the formation of acetate derivatives. (auth)

31895 PHOTOCHEMISTRY OF COORDINATION COMPOUNDS. Balzani, V.; Carassiti, V. London; Academic Press Inc. (1970). 447p. 150s.

Topics covered include: photochemical laws and photochemical kinetics, photophysical processes, basic information on coordination compounds, electronic absorption spectra of coordination compounds, characteristics of the electronically excited states of coordination compounds, chromium, molybdenum and tungsten, manganese, iron, cobalt, platinum, copper, silver and gold, zinc, cadmium, mercury, actinides, other elements, carbonyl complexes, complexes containing π-bonding organic ligands, and dithizonato complexes, and coordination compounds in the solid state. A separate abstract was prepared for one chapter. (M.C.G.)

For an abstract of an individual chapter see: 31896.

31896 ACTINIDES (URANYL COMPOUNDS). pp 286-305 of Photochemistry of Coordination Compounds. /Balzani, V. London; Academic Press Inc. (1970).

The photochemistry of the coordination compounds of uranium is reviewed under the following headings; uranyl compounds (photochemical reactions of uranyl ions with organic compounds-formic acid, acetic acid, oxalic acid, other acids, alcohols, aldehydes, carbohydrates; photochemical reactions of uranyl ions with inorganic compounds; photoinduced polymerization); other uranium compounds. (172 references) (U.K.)

31897 STABLE CESIUM COMPOUNDS. Gray III, John H. (to United States Atomic Energy Commission). U. S. Patent 3,567,646. 2 Mar 1971. Filed 22 Apr 1964.

A stable cesium compound for use as a heat source in a radioisotope-heated thermoelectric generator was prepared using $^{137}CsCl$ from the waste from a controlled fission reaction from U- and Pu-fueled reactors. The $^{137}CsCl$ was converted to $^{137}Cs_2CO_3$, which was then fired with a stoichiometric amount of WO_3 at a temperature between 340 and 600°C to yield $^{137}Cs_2WO_4$. The $^{137}Cs_2WO_4$ was combined with either Nb_2O_5 or Ta_2O_5 at between 1000 and 1400°C to form a stable Cs compound. One to 15 wt % B_2O_3 was added to the Cs compound as a flux to prevent high temperature decomposition. (B.L.M.)

Isotope Effects and Exchange

Refer also to abstracts 31962, 31997, 32018, 32021, 32062, and 33112.

31898 LOW FREQUENCY VIBRATIONS OF MOLECULAR CRYSTALS. XIII. CH_3AsCl_2, CH_3AsBr_2, CH_3AsI_2, AND CD_3AsI_2. Durig, J. R.; Jumper, C. F.; Willis, J. N. Jr. (Univ. of South Carolina, Columbia). Appl. Spectrosc.; 25: 218-25(Mar-Apr 1971).

The IR spectra from 4000 to 33 cm^{-1} were recorded of CH_3AsCl_2, CH_3AsBr_2, CH_3AsI_2, and CD_3AsI_2. The Raman spectra of each of these compounds were recorded and depolarization values measured for CH_3AsCl_2 and CH_3AsBr_2. The observed spectra were successfully interpreted on the basis of a pyramidal skeletal structure of C_s symmetry. The observed values for the Teller–Redlich product rule for the assignments of the normal modes of the CH_3AsI_2 and CD_3AsI_2 molecules are in reasonable agreement with the theoretical values for both symmetry species. The As–CH_3 torsional mode was tentatively assigned in the IR spectrum of solid CH_3AsBr_2 at 134 cm^{-1} and the torsional barrier calculated to be 461 ± 30 cm^{-1} (1.32 ± 0.08 kcal/mole). The low frequency bending modes of solid CH_3AsI_2 and CD_3AsI_2 show correlation field splitting and are successfully explained in terms of the four molecules per unit cell with a space group of C_{2h}^5. (auth)

31899 ISOTOPIC EXCHANGE OF CARBON MONOXIDE ON ZINC OXIDE. Nekipelov, V. N.; Kasatkina, L. A. (Chemical-Tech. Inst., Moscow). Kinet. Katal.; 11: 910-15(Jul-Aug 1970). (In Russian).

The influence of CO_2 adsorption on the kinetics of the homomolecular exchange of carbon monoxide at zinc oxide, the kinetics of isotopic exchange between CO and CO_2, and the exchange of CO with the superficial oxygen of ZnO were investigated. The rate of isotopic CO exchange was compared with the rate of CO oxidation on ZnO. Holding for half an hour in CO_2, like prolonged holding in CO, reduced the activity of ZnO with respect to homomolecular exchange with carbon monoxide. A possible mechanism for the deactivation of zinc oxide in CO and CO_2 atmospheres and the isotopic-exchange mechanism in carbon monoxide molecules are discussed. (auth)

31900 EXCHANGE OF CARBON AND OXYGEN ATOMS OF CARBON DIOXIDE UNDER CONDITIONS OF SYNTHESES FROM CARBON MONOXIDE AND HYDROGEN ON IRON CATALYSTS. Kryukov, Yu. B.; Bashkirov, A. N.; Liberov, L. G.; Smirnova, R. M.; Fridman, R. A. (Inst. of Petrochemical Synthesis, Moscow). Kinet. Katal.; 11: 1069-70(Jul-Aug 1970). (In Russian).

Isotope exchange in CO_2 labeled with ^{14}C and ^{18}O was investigated under conditions of syntheses from CO and H_2 on iron catalysts. Under these conditions the transfer of carbon and oxygen atoms from CO_2 to CO proceeds by different mechanisms. Isotope exchange between CO and $H_2^{18}O$ on iron catalysts was demonstrated. (auth)

31901 INFRARED SPECTRA AND NORMAL VIBRATIONS OF N,N-DIMETHYLFORMAMIDE AND N,N-DIMETHYLTHIOFORMAMIDE. Durgaprasad, G.; Sathyanarayana, D. N.; Patel, C. C. (Indian Inst. of Science, Bangalore). Bull. Chem. Soc. Jap.; 44: 316-22(Feb 1971).

The infrared spectra of N,N-dimethylformamide (DMF) and N,N-dimethylthioformamide (DMTF) were investigated in the range 4000 to 250 cm^{-1}. Assignment of the frequencies of DMF was made on the basis of normal coordinate analysis for DMF, DMF-^{15}N, and DMF-d_7 using Urey–Bradly, modified Urey–Bradley, and symmetrized valence force fields. Calculations were extended to N,N-dimethylthioformamide and N,N-dimethylselenoformamide, using the Urey–Bradley and symmetrized valence force fields. The assignments for DMF from the modified Urey–Bradley field are more satisfactory. The frequency shifts on isotopic substitution and on complexation are explained. The results of the calculations are discussed in comparison with other related molecules. (auth)

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31902 AQUEOUS NONELECTROLYTE SOLUTIONS. PART VIII. DEUTERIUM AND HYDROGEN SULFIDES SOLUBILITIES IN DEUTERIUM OXIDE AND WATER. Clarke, E. C. W.; Glew, D. N. (Dow Chemical of Canada Ltd., Sarnia, Ont.). Can. J. Chem.; 49: 691-8(1 Mar 1971).

A new apparatus is described in which the solubilities of deuterium sulfide in deuterium oxide and of hydrogen sulfide in water were determined with 0.1% accuracy between 0 and 50°C. Solubility equations were derived and the solubility standard thermodynamic function changes, together with their standard errors, tabulated. Equal solubilities would occur at −1°C. The solubility of hydrogen sulfide in water is greater than for deuterium sulfide in deuterium oxide, the solubility difference increases to a maximum at 40°C and thence decreases at higher temperatures. (auth) (Canada)

31903 HOMOGENEOUS AND HETEROGENEOUS PLATINUM-CATALYZED ISOTOPIC HYDROGEN EXCHANGE IN POLYCYCLIC AROMATIC HYDROCARBONS. Davis, K. P.; Garnett, J. L. (Univ. of New South Wales, Kensington, Australia). J. Phys. Chem.; 75: 1175-7(15 Apr 1971).

In the deuteration of a representative number of polycyclics, initial heterogeneous exchange as distinct from competing randomization and identical deuteration patterns between heterogeneous platinum data and the corresponding homogeneous platinum(II) system were observed. In the exchange with both homogeneous and heterogeneous platinum catalysts, the polycyclic aromatic hydrocarbons fall into two groups: condensed polycyclics and the polyphenyls. Identical exchange patterns were observed under homogeneous and heterogeneous conditions using both forward and back exchange methods. (M.C.G.)

31904 MICROWAVE SPECTRUM OF METHYLAMINE. Takagi, Kojiro; Kojima, Takeshi (Toyama Univ., Japan). J. Phys. Soc. Jap.; 30: 1145-57(Apr 1971).

Microwave spectra of CH_3NH_2 and CH_3ND_2 were observed mainly in the 20 to 60 GHz region, and were analyzed by the internal axis method. The spectrum of CD_3ND_2 observed by Lide was reanalyzed. Rotational terms, internal rotation terms, and inversion terms were determined and the inertia constants including I_α were given for each molecule. The barriers to internal rotation are 684.1 cm^{-1}, 678.7 cm^{-1} and 671.7 cm^{-1} for CH_3NH_2, CH_3ND_2 and CD_3ND_2 respectively. Dipole moment and quadrupole coupling constants of CH_3ND_2 were determined. (auth)

31905 ISOTOPIC EFFECTS AND INHIBITION OF POLYSACCHARIDE PHOSPHORYLASE BY 1,5-GLUCONOLACTONE. RELATIONSHIP TO THE CATALYTIC MECHANISM. Tu, Jan-I; Jacobson, Gary R.; Graves, Donald J. (Iowa State Univ., Ames). Biochemistry; 10: 1229-36(30 Mar 1971).

Reaction rates of acid hydrolysis and hydrolysis by alkaline phosphatase were compared to rates obtained with rabbit muscle phosphorylase b and Escherichia coli maltodextrin phosphorylase by using reaction mixtures containing 1-deuterio-α-D-glucose 1-phosphate or the normal isotope. Secondary isotope effects were observed consistent with a mechanism involving a transition state with considerable positive charge similar to that expected for a carbonium ion. Inhibition studies were reported with 1,5-gluconolactone, a compound that possesses a half-chair conformation similar to the oxonium ion. The inhibition is highly specific and competitive with glucose 1-phosphate and noncompetitive with respect to glycogen in the direction of synthesis. For glycogen degradation, 1,5-gluconolactone is noncompetitive either with respect to arsenate or with respect to glycogen. These data have been interpreted to mean that 1,5-gluconolactone competes for the glucosyl transfer site of polysaccharide phosphorylase and that the transition state involves formation of an enzyme glucosyl complex in which the glucosyl residue is in the half-chair conformation. 1,5-Gluconolactone affects the properties of the pyridoxal 5'-phosphate binding site. The possible interaction of 1,5-gluconolactone with pyridoxal 5'-phosphate at the active site is discussed. (auth)

31906 DEEXCITATION OF MOLECULAR VIBRATION COLLISION: VIBRATION-TO-ROTATION ENERGY TRANSFER IN HYDROGEN HALIDES. Shin, Hyung Kyu (Univ. of Nevada, Reno). J. Phys. Chem.; 75: 1079-90(15 Apr 1971).

Vibrational relaxation of hydrogen halides was investigated on the basis of the vibration-to-rotation energy transfer mechanism, with rigorous consideration of the participation of the translational motion. The collision model consists of a rotation-averaged oscillator and a rigid rotator, in which two hydrogen atoms interact strongly at close-in collisions. An expression for the probability of vibration−rotation energy transfer has been formulated by solving Hamilton's equations of motion. Calculated values of the vibrational relaxation times at 1 atm for HCl, DCl, HBr, and HI agree satisfactorily with experiment over the temperature range from 800 to 2000°K. The present treatment also explains the observed isotope effect between HCl and DCl; i.e., the deuterated molecule relaxes more slowly than the normal molecule in spite of the fact that its vibrational frequency is significantly smaller than that of the normal molecule. The effect of the translational motion on vibrational relaxation is found to be most important in the hydrogen chloride molecules, the deuterated chloride being more significantly affected by the translational motion than the normal molecules, while in the hydrogen iodide molecules the effect is least important. (auth)

31907 ISOTOPE EFFECTS IN AUTOXIDATION. VI. COMPARISON OF NON-LABELED AND DEUTERIUM-LABELED POLY(VINYL CHLORIDE) AS TO THEIR STABILITY AGAINST THERMOOXIDATION. Trauzeddel, R.; Huebner, H.; Wetzel, K. (Deutsche Akademie der Wissenschaften zu Berlin, Leipzig). Isotopenpraxis; 6: 409-11(Nov 1970). (In German).

Syntheses of deuterated PVC under different conditions are described. Measurements of its stability in the presence of oxygen at 180°C are discussed in relation to the values for ordinary PVC. The ir spectra were taken to explain the degradation mechanism. (auth)

31908 ISOTOPIC EXCHANGE REACTION IN SOLID STATE BETWEEN Cr(III) OXINATE AND DOPANT $^{51}Cr^{3+}$ IONS. Lazzarini, E.; Annoni, T.; Fantola-Lazzarini, A. L. (Politecnico, Milan). Radiochim. Acta; 15: 93-5(Mar 1971).

The solid-state exchange of ^{51}Cr in chromium oxinate crystals doped with Cr^{3+} on heating was studied by thin-layer chromatography. A ^{51}Cr-labeled intermediate compound was formed and part of it decomposes so that part of the Cr^{3+} dopant ions undergo isotopic exchange. (M.C.G.)

31909 ^{14}C ISOTOPE EFFECTS IN THE FORMOLYSIS AND TRIFLUOROACETOLYSIS OF 2-ARYL-(ARYL-^{14}C)-ETHYL p-NITRO BENZENE SULPHONATES. Yukawa, Y.; Ando, T.; Kawada, M.; Token, K.; Kim, S. G. (Osaka Univ.). Tetrahedron Lett.; 13: 847-50(Mar 1971).

Studies are reported on the ^{14}C isotope effect of 2-phenyl-(phenyl-1-^{14}C)-ethyl p-nitrobenzenesulphonate and 2-(4-methoxyphenyl-(phenyl-1-^{14}C)-ethyl p-nitrobenzenesulphonate in formic acid and trifluoroacetic acids. Data are presented in tabulated form. Both compounds showed a definite positive ^{14}C isotope effect in formolysis and trifluoroacetolysis, although no isotope effect was found in the acetolysis of the first compound. This indicates a change in the bonding of the phenyl-1 C-atom in the rate determining step, demonstrating the presence of phenyl participation as well as anisyl participation in the formolysis and trifluroacetolysis. (UK)

31910 RELATION BETWEEN THE ISOTOPE EFFECT FOR DIFFUSION AND THE CORRELATION FACTOR IN SYSTEMS LACKING A TWO-FOLD SYMMETRY AROUND THE TRACER JUMP VECTOR. Bakker, H. (Univ., Amsterdam). Phys. Status Solidi (b); 44: No. 1, 369-80(1 Mar 1971).

Conditions under which the isotope effect, E, and the correlation factor, f, for diffusion by means of complex lattice defects (lacking a two-fold symmetry around the tracer−defect jump vector) are connected by $E = f\Delta K$ were investigated. It is shown, that the conditions are fulfilled for (impurity) diffusion by divacancies and for diffusion by vacancy−impurity pairs in fcc metals. (auth)

31911 SPECIFIC SALT EFFECTS UPON THE RATES OF SnI SOLVOLYSES. Bunton, C. A.; Del Pesco, T. W.; Dunlop, A. M.; Yang, K.-U. (Univ. of California, Santa Barbara. University Coll., London). J. Org. Chem.; 36: 887-97(9 Apr 1971).

Specific kinetic salt effects on the solvolyses of tert-butyl bromide, 1- and 2-methyl-exo-2-chloronorbornane, isobornyl chloride, and camphene hydrochloride have been examined in methanol, aqueous methanol, acetone, 1,2-dimethoxyethane, and methanol-1,2-dimethoxyethane. Anion effects are important but cation effects are small (for Li^+, Na^+, and Et_4N^+). The anion order is ClO_4^- > $OTos^-$ ≈ NO_3^- ≈ Br^- > Cl^- ≈ no salt > F^- > OH^-. Isotopic and azide trapping experiments show that carbonium ions or ion pairs can return in solvolyses of camphene hydrochloride and tert-butyl chloride, but return is not large enough to explain the salt effects. This conclusion is supported by the observation of specific salt effects upon solvolyses of isobornyl chloride and 1-methyl-exo-2-chloronorbornane. Retention of configuration in the methanolysis of isobornyl chloride and camphene hydrochloride shows that methyl or hydride shifts do not occur during the lifetime of the carbonium ions. Experiments on isobornyl chloride in aqueous methanol and acetone show that chloride and perchlorate ions have little effect upon the activity coefficient of the

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substrate. The transition state effects appear to be related, at least in part, to solvent structure induced interactions between the carbonium-like transition state, especially with a large anion such as perchlorate. (auth)

31912 α-CHLORODICYCLOPROPYL SULFONE. ITS SYNTHESIS AND BEHAVIOR TOWARD BASES. Paquette, Leo A.; Houser, Robert W. (Ohio State Univ., Columbus). J. Org. Chem.; 36: 1015-16(9 Apr 1971).

Butyl lithium was used to induce cyclization of γ, γ'-dichlorodipropyl sulfone to give dicyclopropyl sulfone, which was chlorinated to give α-chlorodicyclopropyl sulfone which was found to be particularly resistant to the α-halo sulfone arrangement and to undergo ready hydrogen–deuterium exchange in $NaOCH_3$–CH_3OD. It was concluded that the energy barrier is encountered in the requisite intramolecular nucleophilic displacement of the chloride ion. (D.P.O.)

31913 INFRARED STUDY OF THE SURFACE OF TITANIUM DIOXIDES. I. HYDROXYL GROUPS. Primet, Michel; Pichat, Pierre; Mathieu, Michel-Vital (CNRS, Villeurbanne, France). J. Phys. Chem.; 75: 1216-20(29 Apr 1971).

The stretching frequencies of the OH groups of anatase and rutile were tentatively related to the positions of these groups in the crystal lattices. Exchange of these OH groups with D_2O vapor or D_2 gas was examined by infrared spectrometry. All the hydroxyl groups are exchangeable with D_2O. Depending on the temperature, D_2 acts as either an exchange or a reducing agent. In order to explain the results of the dehydroxylation–rehydroxylation cycles, the formation of incompletely coordinated titanium atoms is proposed. This formation is confirmed by the ionization of perylene. (auth)

31914 COHESIVE ENERGIES OF THE ALKALI HYDRIDES AND DEUTERIDES. Bowman, R. C. Jr. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. J. Phys. Chem.; 75: 1251-5(29 Apr 1971).

The effect of isotopic substitution on cohesive energies of alkali hydrides was estimated using Born-Mayer equations. Second-neighbor interactions and van der Waals terms were included in the calculations. Vibrational contributions were obtained from Debye lattice theory. Theoretical cohesive energies are in excellent agreement with experimental values. Differences between calculated hydride and deuteride cohesive energies are slightly larger than experimental differences. Estimates of compressibilities and Debye temperatures are also given. (auth)

31915 HYDROGEN–DEUTERIUM EXCHANGE REACTIONS IN THE GROUND AND EXCITED STATES OF NAPHTHALENE. Stevens, Charles Guernsey. Boulder, Colo.; Univ. of Colorado (1970). 133p. University Microfilms Order No. 71-5936.

Thesis.

The results of hydrogen-deuterium exchange reactions of both ground and photo-excited naphthalene in moderately concentrated sulfuric acid are reported. In the ground state study, the de-deuteration of α-naphthalene-d_1 and β-naphthalene-d_1 was followed as a function of both acid composition (50 to 67%) and temperature (15 to 55°C). The rate constants for exchange at the α position are approximately 15 times greater than those for exchange at the β position in this range of concentration. These constants are correlated with the Hammett acidity function (H_0). The slopes of log k vs. $-H_0$ are significantly different for the two positions of exchange at all temperatures. The slopes, at 25°C, are 1.50 for α-exchange and 1.60 for β-exchange. The results are interpreted in terms of the extreme hydration hypothesis, which is shown to be inadequate for a complete explanation of the data. The thermodynamic quantities, $\Delta S^{\ddagger}$, $\Delta H^{\ddagger}$, and $\Delta G^{\ddagger}$ are calculated from the temperature dependence of the rate constants. Investigation of the photoinduced de-deuteration of α-naphthalene-d_1 and β-naphthalene-d_1 was conducted as a function of acid composition in the range of 30 to 67% sulfuric acid at 25°C. The quantum yields increase rapidly at low acid concentration and approach a constant value at high acid concentration. At higher acid concentrations, above 60%, the quantum yields for exchange at the β position are greater than those for the α position by a factor of approximately 1.2. At lower acid concentrations there is an apparent reversal in the relative values with the quantum yields for exchange at the α position greater than those for the β position. The quenching of naphthalene fluorescence by sulfuric acid in the range 50 to 70% was observed and studied quantitatively. The results are correlated with the Hammett acidity function, H_0, of the medium. A plot of the logarithm of the appropriate quenching function against $-H_0$ shows good linearity and has a slope value of 0.85. These quenching results along with studies of the exchange reaction and delayed emission quenching in de-oxygenated solutions provide evidence, which strongly supports the proposition that the 1st excited singlet state of naphthalene is the exchanging state. A kinetic mechanism was adopted, which correctly accounts for the observed mutual dependence of the quantum yields of exchange and quenching and also accounts for the dependence of these yields upon the acidity of the medium. The mechanism is analogous to the generally accepted 2-step process for the ground state exchange. This mechanism predicts a primary kinetic isotope effect of at least 1.5. An examination of the isotope effect failed to confirm its existence because of experimental uncertainties. An alternative mechanism is presented that does not require the existence of an isotope effect. Kinetic equations were derived from the proposed mechanism which show that the ratio of quantum yields for exchange at α and β positions is a close approximation to the ratio of rate constants for the protonation step of the reaction. At high acid concentrations the relative reactivities of the α and β position are reversed in going from the ground state to the 1st excited singlet state. (Diss. Abstr. Int., B)

31916 STUDIES IN CHROMIC ACID OXIDATION. Farnum, Bruce Wayne. Newark, Del.; Univ. of Delaware (1970). 136p. University Microfilms Order No. 71-6468.

Thesis.

2,2,4,4-Tetramethyl-1,3-cyclobutanediol was oxidized with chromium trioxide in 90% acetic acid. Products isolated included 3-hydroxy-2,2,4,4-tetramethylcyclobutanone, 2,2,4,4-tetramethylcyclobutanedione, acetone, isobutyraldehyde, 3-keto-2,2,4-trimethylpentanal, acetate and formate esters of the starting diol, and the previously unreported gamma lactone of 4-hydroxy-3-keto-2,2,4-trimethylpentanoic acid. When 2,2,4,4-tetramethylcyclobutanedione was oxidized with a two fold excess of chromic acid, all the dione was destroyed and the gamma lactone of 4-hydroxy-3-keto-2,2,4-trimethylpentanoic acid was obtained in 35% yield, along with traces of acetone, carbon monoxide, and carbon dioxide. Similarly, 2,2,4,4-tetramethylcyclobutanone was converted to gamma lactone of 4-hydroxy-2,2,4-trimethypentanoic acid. Chromic acid has not previously been reported to carry out Baeyer–Villiger type transformations. Base catalyzed hydrolysis of gamma lactone of 4-hydroxy-3-keto-2,2,4-trimethylpentanoic acid yielded 2-hydroxy-2,4-dimethyl-3-pentanone. Oxidation of derivatives was consistent with a fast ester interchange between ditertiarybutyl chromate and secondary carbinol. The substituent effects observed were primarily those of the oxidative decomposition step, and represent the first direct observation of a positive rho for oxidation by chromium (VI). These results are in accord with the Westheimer mechanism for chromic acid oxidation. Intermediate range deuterium isotope effects were observed. (Diss. Abstr. Int., B)

31917 THERMODYNAMIC FUNCTIONS AND PHASE DIAGRAMS OF TANTALUM + HYDROGEN AND TANTALUM + DEUTERIUM SYSTEMS. Pryde, J. A.; Tsong, I. S. T. (Sir John Cass Coll., London). Trans. Faraday Soc.; 67: 297-304 (Feb 1971).

Ultrahigh vacuum techniques were applied to investigate the solubilities of hydrogen and deuterium in tantalum. Measurements of equilibrium pressure and electric resistance were used to outline the phase diagram, to investigate the isotope effect, and to determine the variation of thermodynamic properties with composition. All experimental measurements were taken in (pressure, composition, temperature) ranges of 10^{-6} to 10^{-1} torr (1 torr = 133.32 N m^{-2}), 0.0036 to 0.78 (H or D)/Ta atomic ratio and –78 to 240°C respectively. (auth) (UK)

31918 H_2O, HDO, AND CH_3OH INFRARED SPECTRA AND CORRELATION WITH SOLVENT BASICITY AND HYDROGEN BONDING. Glew, D. N.; Rath, N. S. (Dow Chemical of Canada Ltd., Sarnia, Ont.). Can. J. Chem.; 49: 837-56(15 Mar 1971).

A study was made of the infrared O–H bands for CH_3OH, DOH, and H_2O in solution and of their correlation with hydrogen bonding and solvent basicity. Infrared bands for the three fundamentals and the first bending overtone of H_2O and for the O–H stretching fundamentals of DOH and CH_3OH were measured between 30 and –40°C in a solvent range extending from weakly interacting fluorocarbons to strongly hydrogen-bonding organic amines. The O–H stretching bands for the weakly acidic solutes CH_3OH, DOH, and H_2O are mostly Lorentzian in shape and move to lower frequencies with higher extinctions in the more basic solvents. Many correlations are found between the stretching frequencies and band areas, and between the frequencies and solvent basicity. Monofunctional CH_3OH is found to be a stronger acid and forms stronger hydrogen-bonds with a given base than do the doubly bonded DOH and HOH which show equal dibasic acid strengths. The wide, overlapped, fundamental stretching bands for H_2O strongly hydrogen-bonded to the tertiary amines and for ice were partially resolved and unequivocally assigned, showing

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that there is no cross-over of the ν_3 and ν_1 bands despite the strong hydrogen-bonding. At higher temperatures in solvents containing both hydrophobic and strongly basic groups, water was found with the lower C_s type symmetry, in which unbonded O–H groups gave sharp bands in the 3680 to 3650 cm^{-1} region in addition to the wide hydrogen-bonded bands at lower frequencies. (auth) (Canada)

31919 METASTABLE IONS AND ISOTOPE EFFECTS IN THE MASS SPECTRA OF METHANE AND THE DEUTEROMETHANES. Hills, Lorin P.; Vestal, Marvin L.; Futrell, Jean H. (Univ. of Utah, Salt Lake City). J. Chem. Phys.; 54: 3834-45(1 May 1971).

A differentially pumped double focusing mass spectrometer was suitably modified for the study of metastable ions and collision-induced metastables. At high resolution the same instrument easily resolved protonated and deuterated ions of the same nominal mass. Accordingly, metastable ions and isotope effects in the mass spectra of CH_4, CH_3D, CH_2D_2, and CD_4 were reinvestigated with this instrument in order to resolve certain ambiguities in previous studies. All four protonated molecular ions exhibited hydrogenloss metastables, while CD_4^+ exhibited a corresponding unimolecular elimination of a deuterium atom. In addition to these true metastables, essentially every conceivable collision-induced metastable decay process was also observed. The observed relative intensities and isotope effects in the normal spectra are rationalized with general statistical arguments and with more complete calculations using the quasiequilibrium theory of mass spectra. The behavior of the rates at threshold and their effect on methane metastable intensities are also discussed. (auth)

31920 KINETICS AND MECHANISM OF THE DECARBOXYLATION OF PYRROLE-2-CARBOXYLIC ACID IN AQUEOUS SOLUTION. Dunn, G. E.; Lee, G. K. J. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 49: 1032-5(1 Apr 1971).

The decarboxylation of pyrrole-2-carboxylic acid in aqueous buffers at 50° and ionic strength 1.0 was found to be first order with respect to substrate at a fixed pH. As the pH is decreased, the rate constant increases slightly in the pH range 3–1, then rises rapidly from pH 1 to 10 M HCl. The ^{13}C-carboxyl kinetic isotope effect is 2.8% in 4 M $HClO_4$ and negligible at pH ~ 3. These observations can be accounted for by a mechanism previously proposed for the decarboxylation of anthranilic acid, in which the species undergoing decarboxylation is the carboxylate ion protonated at the 2-position of the pyrrole ring. This intermediate can be formed both by ring-protonation of the carboxylate anion and by ionization of the ring-protonated acid. At low acidities ring-protonation is rate determining, but at higher acidities the rate of protonation exceeds that of decarboxylation. (auth) (Canada)

31921 VAPOR PRESSURES OF LIQUID ORTHO-PARA SOLUTIONS OF DEUTERIUM; EXCESS THERMODYNAMIC FUNCTIONS AND INTERMOLECULAR FORCE CONSTANTS. Meckstroth, W. K.; White, David (Univ. of Pennsylvania, Philadelphia). J. Chem. Phys.; 54: 3723-9(1 May 1971).

The difference in vapor pressure between equilibrium deuterium (2.15% para) and solutions of higher para composition were measured as a function of temperature for the liquid. Several measurements in the solid state are also reported. All of the excess functions were derived from the measurements as well as the ratio of fugacities of the pure components. The statistical mechanical treatment of Babloyantz and Bellemans is used to account for the nonidealities of the ortho–para solutions and to obtain parameters of both the angle-dependent electric quadrupole–quadrupole interactions and the isotropic interactions represented by the Lennard–Jones function. These same parameters account for the experimental results in the case of the isotope hydrogen, indicating that the model is generally applicable. (auth)

31922 SUBMILLIMETER-WAVE SPECTRA AND EQUILIBRIUM STRUCTURES OF THE HYDROGEN HALIDES. De Lucia, Frank C.; Helminger, Paul; Gordy, Walter (Duke Univ., Durham, N. C.). Phys. Rev., A; 3: 1849-57(Jun 1971).

Rotational transitions of a number of isotopic species of hydrogen halides were measured in the 1.0 to 0.38 mm wavelength region of the spectrum. These transitions were measured with a submillimeter-wave spectrometer which employs a klystron-driven crystal harmonic generator and a 1.6°K InSb photoconducting detector. The following results were obtained: for H ^{35}Cl, B_0 = 312 989.297 ± 0.020 Mc/sec, D_0 = 15.836 Mc/sec, r_e = 1.274 5991 Å; for H ^{37}Cl, B_0 = 312 519.121 ± 0.020 Mc/sec, D_0 = 15.788 Mc/sec, r_e = 1.274 5990 Å; for D ^{35}Cl, B_0 = 161 656.238 ± 0.014 Mc/sec, D_0 = 4.196 ± 0.003 Mc/sec, r_e = 1.274 5990 Å; for D ^{37}Cl, B_0 = 161 183.122 ± 0.016 Mc/sec, D_0 = 4.162 ± 0.003 Mc/sec, r_e = 1.274 5988 Å; for H ^{127}I, B_0 = 192 657.577 ± 0.019 Mc/sec, D_0 = 6.203 ± 0.003 Mc/sec, r_e = 1.609 018 Å; for D ^{127}I, B_0 = 97 537.092 ± 0.009 Mc/sec, D_0 = 1.578 ± 0.001 Mc/sec, r_e = 1.609 018 Å; for D ^{79}Br, B_0 = 127 357.639 ± 0.012 Mc/sec, D_0 = 2.6529 ± 0.0014 Mc/sec, r_e = 1.414 4698 Å; for D ^{81}Br, B_0 = 127 279.757 ± 0.017 Mc/sec, D_0 = 2.6479 ± 0.0020 Mc/sec, r_e = 1.414 4698 Å; for D ^{19}F, B_0 = 325 584.98 ± 0.300 Mc/sec, D_0 = 17.64 Mc/sec, r_e = 0.916 914 Å. (auth)

31923 DECOMPOSITION MECHANISMS OF $Mg(OH)_2$ AND $Mg(OD)_2$. PART II. Naegerl, H.; Freund, F. (Univ., Goettingen, Ger. Univ., Cologne). J. Therm. Anal.; 2: 387-95(1970). (In German).

The conditions were studied under which the proton of an ionic OH^- group can leave the electron cloud of the O^{2-} ion to form a H_2O molecule with a neighboring OH^- group. The condition tunnelling is the presence of a free acceptor level of similar height in the neighboring OH^- group. If the two OH^- groups are equivalent crystallographically, this condition is not fulfilled since the acceptor level lies higher than the donor level. Coupling with the opposite-phase OH bending vibrations leads to a broadening of the levels and finally to an overlap, which renders the tunnelling possible. The proton transfer starts at the surface as, at any given temperature, the amplitude of the effective OH bending vibrations is larger at the surface than inside the crystal. (auth)

31924 ISOTOPE EXCHANGE IN STIRRED SUSPENSIONS. Melikhov, I. V.; Pechnikov, V. G. (Moscow State Univ.). Russ. J. Phys. Chem. (Engl. Transl.); 44: 1267-72(Sep 1970).

A kinetic study was made of isotope exchange between stable microcrystals of potassium sulfate and an aqueous solution during turbulent stirring of the suspension. Stirring at rates exceeding a definite threshold value (exchange threshold) accelerates the exchange. This effect is unconnected with Ostwald aging, but is due to the formation of structural defects during collisions of crystals unaccompanied by dispersion of the solid phase over a wide range of rates of rotation, which results in the formation of a peripheral zone of crystals having high ionic mobilities and diminished pyknometric density, and also produces an increase in the permeability of the intercrystalline boundaries. The mobility of the ions in the peripheral zone increases on dissolution and decreases with growth in the crystals, which is explained by the formation of a reinforcing layer of the solid phase adjacent to the surface. (auth)

31925 HYDRODYNAMIC STUDIES OF HUMAN LOW DENSITY LIPOPROTEINS. EVALUATION OF THE DIFFUSION COEFFICIENT AND THE PREFERENTIAL HYDRATION. Fisher, Waldo R.; Granade, Mary Ethel; Mauldin, Jack L. (Univ. of Florida, Gainesville). Biochemistry; 10: 1622-9(27 Apr 1971).

Additional hydrodynamic properties of plasma low density lipoproteins (LDL) isolated from two normal human subjects were evaluated. Measurements of the diffusion coefficient were performed in solvents containing 0.2 M KCl or 1.4 M KBr. In both solvents $D^0_{25}, W = 2.17 \times 10^{-7}$ cm^2/sec. $\bar{V}$ was calculated for LDL from s vs. density plots in solutions in which the density was adjusted with D_2O or KRr, and the values found were 0.966 and 0.967 ml per g, respectively. The sedimentation coefficient was also evaluated in D_2O and KBr containing solutions, and for these subjects $s^0_{25,\rho\ 1.20} = -38$. The calculated anhydrous molecular weight of LDL from these two subjects is 2.73×10^6 g/mole, and the molecular weight measured in solutions containing KBr does not differ. On the basis of the linearity of the s vs. density plot, the identity of the hydrated density of LDL in H_2O-D_2O and in KBr containing solutions, and the failure of high KBr concentrations to alter the measured value of D, it is concluded that LDL is not preferentially hydrated in KBr solutions. On evaluation of the frictional coefficient, and f/f_0 ratio of 1.11 was calculated, and, if these molecules are assumed to be spheres, as is suggested by published electron micrographs, then the maximum hydration of LDL is 0.34 g/g of lipoprotein. (auth)

31926 NEAR INFRARED SPECTRA OF 2-, 3-, AND 4-AMINOPYRIDINES AND THEIR DEUTERATED ANALOGUES. Padhye, M. R.; Bhujle, V. V. (Univ. of Bombay). Indian J. Pure Appl. Phys.; 8: 479-82(Aug 1970).

The near infrared spectra of three isomeric aminopyridines and their deuterated analogues were recorded. An analysis of combination and overtone bands involving amino group frequencies is presented. The overtones of the bands due to dimers of aminopyridines, clearly observed in fundamental region, were not observed in near infrared spectra. (auth)

31927 DIMERIZATION OF α-CHYMOTRYPSIN. II. IONIC STRENGTH AND TEMPERATURE DEPENDENCE. Aune, Kirk C.;

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Goldsmith, Lowell C.; Timasheff, Serge N. (Brandeis Univ., Waltham, Mass.). Biochemistry; 10: 1617-22(27 Apr 1971).

The acid dimerization equilibrium constant of α-chymotrypsin was determined by the method of sedimentation equilibrium as a function of ionic strength and temperature. It was found that this reaction is accompanied by the apparent preferential binding of salt, a negative change in heat capacity, and a positive entropy at low temperature. Change of medium from H_2O to D_2O enhanced the dimerization. Perchlorate ions were found to strengthen dimer formation, while sulfate weakened it. Analysis of these thermodynamic observations led to the conclusions that water leaves the domain of the intermolecular contact region when the dimer forms and that the released water comes not only from hydrophobic sites, but also from the hydration shells of charged groups in the contact region. (auth)

31928 ISOTOPE EFFECTS IN THE SPECIFIC HEAT OF SOLID NEON. Somoza, Eugene; Fenichel, Henry (Univ. of Cincinnati). Phys. Rev., B; 3: 3434-46(15 May 1971).

Specific heat measurements of ^{20}Ne and ^{22}Ne are reported in the temperature range 2.5 to 23.5 K. The measurements were made simultaneously on the two isotopes in a calorimeter employing a mechanical heat switch. The results are presented in the form of tables of smoothed values of the following thermodynamic properties: specific heat at constant pressure, specific heat at constant volume, entropy, enthalpy, and the Grüneisen parameter. The results are compared with the Nerst–Lindemann equation, the Grüneisen equation of state, and the theoretical calculations of Barron, Gupta, et al., Gillis, et al., and Goldman, et al. Excellent agreement is found at low temperatures between the present results and calculations based on anharmonic models. However, discrepancies arise at higher temperatures. (auth)

31929 DIRECT OBSERVATION OF THE TORSIONAL VIBRATIONS IN ISOBUTYLENE, ISOBUTYLENE-d_8, AND ISOBUTYLENE-d_9 BY RAMAN SCATTERING. Harris, William C.; Levin, Ira W. (National Insts. of Health, Bethesda, Md.). J. Chem. Phys.; 54: 3227-9(1 Apr 1971).

The low-frequency Raman spectra of polycrystalline isobutylene, isobutylene-d_8, and isobutylene-d_9 are recorded at liquid nitrogen temperature and the observed torsional Raman frequencies are summarized. (D.P.O.)

31930 STEREOCHEMISTRY OF SILICON-HALOGEN BONDS: RACEMIZATION AND CHLORIDE EXCHANGE STUDIES. Homer, George David. Davis, Calif.; Univ. of California (1970). 167p. University Microfilms Order No. 71-7935.

Thesis.

The racemization reactions of several optically active triorganosilicon halides were studied kinetically under a variety of conditions. The compounds investigated were (α-$C_{10}H_7$)(C_6H_5)(CH_3)Si*X, where X denotes Cl, Br, and F, (α-$C_{10}H_7$)(C_6H_5)(CH_3)Si*Cl, (C_6H_5)(C_6H_5)(CH_3)Si*Cl, and (C_6H_5)$_2$SiSi*(C_6H_5)(CH_3)Cl. The racemization reactions catalyzed by tertiary aromatic phosphines were found to be a function of several parameters. These parameters included strong nucleophilic "push," strong electrophilic "pull," Si–X bond energy (the stronger the Si–X bond the slower the rate), weak to moderate steric effects, and weak to moderate rate enhancement with increased electropositive character on silicon. Furthermore, a fine balance was found to exist between these parameters. All the racemizations were first order in the silicon halide and first order in the phosphine. The racemizations of (α-$C_{10}H_7$)(C_6H_5)(CH_3)Si*Cl with phosphonium salts in purified chloroform solvent were also studied. The racemization and chloride exchange reactions between cyclo-$C_6H_{11}\overset{+}{N}H_3{}^{36}Cl^-$ and the optically active organosilicon chlorides were investigated in purified chloroform solvent. The $k_{(rac)}/k_{exchange}$ ratios varied from 1.04 to 1.95. The ratio of 1.04 was observed for (α-$C_{10}H_7$)(C_6H_5)(CH_3)Si*Cl and the ratio of 1.95 was observed for (α-$C_{10}H_7$)(C_6F_5)(CH_3)Si*Cl. Both the racemization and exchange rates showed first order dependence on the added salt in all cases. Analogous chloride exchange reactions for triethylchlorosilane and 1-chloro-1-silabicyclo-[2.2.1]-heptane showed that the bridgehead chlorosilane reacted 41 times slower than the acyclic chlorosilane. All the data were explained in terms of a "push-pull" mechanism scheme. (Diss. Abstr. Int., B)

31931 STUDY OF STRAINED C–C BOND FISSION. Ding, Janyih. Syracuse, N. Y.; Syracuse Univ. (1970). 134p. University Microfilms Order No. 71-7757.

Thesis.

Acetic acid-d was added to bicyclo[2.1.0]pentane and bicyclo[3.1.0]hexane, and acetic acid was added to bicyclo[2.1.0]-pentane-5, 5-d_2 and bicyclo[3.1.0]hexane-6, 6-d_2. The acetates obtained from ring-opening were converted to alcohols with lithium aluminum hydride. The alcohols were oxidized to their ketones with Jones' reagent and the deuterium-hydrogen exchange of the ketones was accomplished by treating the ketone with sodium methoxide and methanol solution. The products obtained in each step were isolated by gas chromatography and the determination of the isotopic distribution of the products was achieved by mass spectral analysis. The analysis of the products obtained from external ringopening of bicyclo[3.1.0]hexane system showed that no deuterium loss was found in the corresponding alcohols, and ketones, before and after exchange. The results also indicated that no deuterium rearrangement occurred during the ring-opening. The mass spectral analysis of the alcohols and ketones originating from internal ring-opening, before and after deuterium-hydrogen exchange, indicates that deuterium rearrangement occurred during the ring-opening. A carbonium ion mechanism is not important because no significant amount of d_2 species of the ketones, obtained from ring-opening of bicyclo[2.1.0]pentane-5, 5-d_2 and bicyclo[3.1.0]hexane-6, 6-d_2, survived after deuterium-hydrogen exchange. A protonated cyclopropane intermediate was postulated to account for the mechanism of the ring-opening. Two possible paths for the rearrangement are proposed and discussed. The syntheses of 2,3-dideuterionorbornene were also attempted. (Diss. Abstr. Int., B)

31932 SOLVOLYTIC MECHANISM AND SECONDARY DEUTERIUM ISOTOPE EFFECTS OF PROPARGYL DERIVATIVES. Dowd, William. Bloomington, Ind.; Indiana Univ. (1970). 241p. University Microfilms Order No. 71-6930.

Thesis.

The solvolytic reaction mechanisms for a series of primary and secondary propargyl derivatives were investigated in a variety of ethanol–water, trifluoroethanol–water and hexafluoroisopropanol–water solvents. The α-secondary isotope effect and, in some cases, β and δ secondary deuterium isotope effects for these compounds were determined. The products of the reactions were investigated. The steric result of substitution for the solvolysis of optically active 3-butyn-2-yl-p-bromobenzenesulfonate was determined in some of the solvents listed above. The solvolysis of optically active 2-octyl-p-bromobenzenesulfonate in trifluoroacetic acid was investigated. The solvolysis mechanism of two different 1-adamantyl carbinyl derivatives was determined as well as their α-secondary deuterium isotope effects in the series of alcohol–water solvents. The optical results for HC ≡ C–CH(OBs)CH_3 in ethanol–water mixtures and trifluoroethanol–water mixtures gave complete inversion of products. The steric course of substitution in hexafluoroisopropanol gave 80.7% overall inversion and 19.3% overall retention. The optical results for 2-octyl OBs in trifluoroacetic acid gave 63.7% overall inversion for the substitution product formed. The product of the solvolysis reactions was investigated. In ethanol–water mixtures, the selectivity for ethanol over water for the different compounds followed the order: RC ≡ CCH_2X > HC ≡ C–CH(X)CH_3 > CH_3C ≡ CCH(X)CH_3. In trifluoroethanol–water the selectivity for water over trifluoroethanol for the different compounds followed the order CH_3C ≡ CCH(X)CH_3 > HC ≡ CCH(X)CH_3 ≃ RC ≡ CCH_2X. The products for CH_3C ≡ CCH(X)CH_3 are different in the same solvent for different X's. The isotope effects, product results and stereochemical results are discussed in terms of a unified ion-pair reaction mechanism. (Diss. Abstr. Int., B)

31933 STEREOCHEMISTRY OF VINYL ANIONS. Turner II, Laurence McCue. Tallahassee; Florida State Univ. (1970). 119p. University Microfilms Order No. 71-7122.

Thesis.

The stereochemical fate of vinyl anions was studied in order to evaluate the role of hybridization order in carbanion configurational stability. The method involved a comparison of the rate of hydrogen-deuterium exchange with the rate of isomerization. 2,2,4,6,6-pentamethylcyclohexylideneacetonitrile (1) was synthesized in racemic form and also was resolved via the corresponding acid, 2,2,4,6,6-pentamethylcyclohexylideneacetic acid. The deuterated and tritiated analogues of 1 were prepared also. The rate constants of hydrogen–deuterium (k_H), deuterium-hydrogen (k_D), and tritium–hydrogen (k_T), exchanges in methanol containing 1N sodium methoxide were measured. The rate constant (k_r), for racemization of optically active 1 was measured under the same conditions. The ratio k_H/k_r was found to be 140 at 90° corresponding to 99.3% retention of configuration. The possibility of exchange occurring by the addition and later elimination of base was eliminated, as the addition product would be a symmetric molecule and racemization would occur twice as fast as exchange. The isotope effects k_H/k_D and k_H/k_T were small (ca. 2) and increased slightly with increasing temperature. The activation entropy increased significantly in the order T–H < D–H < H–D. The results indicate that the rate limiting step of the exchange is not the removal of the olefinic proton but the interchange of associated solvent molecules. (Diss. Abstr. Int., B)

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31934 PHOTOCHEMISTRY OF AROMATIC KETONES IN SOLUTION. Curtis, Howell Cosby. Tallahassee; Florida State Univ. (1970). 145p. University Microfilms Order No. 71-6990.
Thesis.

The photooxidation of benzil is shown not to involve singlet oxygen and benzoyl peroxide as intermediates. The key step is interaction of triplet benzil with ground-state oxygen to give a diradical intermediate, which cleaves to benzoylperoxy and benzoyl radicals. Benzoyloxy radicals and benzoyl peroxide are formed by interaction of benzoylperoxy radicals. The photochemical decomposition of benzoyl peroxide in benzene in the presence of oxygen is studied in detail. Addition of benzoloxy radicals to benzene is shown to be reversible, since the ratio of phenyl benzoate to biphenyl is dependent upon the oxygen concentration. A large isotope effect for formation of phenyl benzoate is observed, whereas the isotope effect for biphenyl formation is small. Photolysis of benzil in the absence of oxygen gives benzoyl radicals, which are trapped by abstraction of chlorine atoms from carbon tetrachloride. About one percent cleavage at the phenyl–carbonyl carbon bond takes place. The photoreduction of benzophenone in pure benzene is shown to involve phenyl radical intermediates, which arise by hydrogen abstraction from benzene. A large isotope effect on biphenyl formation is observed. The short lifetime of benzophenone in benzene is due to a specific interaction with solvent. (Diss. Abstr. Int., B)

31935 ISOTOPE EXCHANGES INVOLVING VARIOUS ISOMORPHOUS 6-MOLYBDO AND 6-TUNGSTO HETEROPOLY ANIONS. THE EXCHANGE OF INTACT CrO_6 UNITS. Lee, Kah-hock. Washington, D. C.; Georgetown Univ. (1970). 244p. University Microfilms Order No. 71-6046.
Thesis.

Three complexes were studied, $[CrO_6Mo_6O_{18}H_6]^{-3}$, $[NiO_6Mo_6O_{18}H_6]^{-4}$, and $[NiO_6W_6O_{18}H_6]^{-4}$. The relatively rapid ($t_{\frac{1}{2}}$ = 16 to 72 min. at 30°C.) exchange of ^{51}Cr between $[Cr(H_2O)_6]^{+3}$ and $[CrO_6Mo_6O_{18}H_6]^{-3}$ was studied under various conditions. It is believed that this heteropoly species is the first example of a Cr(III) complex which exchanges its Cr relatively rapidly. The three-way exchange of ^{18}O between $[Cr(H_2O)_6]^{+3}$, $[CrO_6Mo_6O_{18}H_6]^{-3}$, and solvent H_2O was also studied under comparable conditions and starting with the label in different places. It was necessary to derive new exchange rate equations in order to solve the problem of the three-way ^{18}O exchange. Computer programs for the reduction of the data were devised. The data and treatment show that six O atoms from $[Cr(H_2O)_6]^{+3}$ appear in the heteropoly complex at the same rate at which one Cr atom appears there from $[Cr(H_2O)_6]^{+3}$. The apparent ^{18}O exchange rate between $[Cr(H_2O)_6]^{+3}$ and $H_2{}^{18}O$ in the presence of $[CrO_6Mo_6O_{18}H_6]^{-3}$ is markedly slower than that between the same species in the absence of the heteropoly anion. The data are combined to prove that CrO_6 exchanges as a unit, with unbroken Cr–O bonds, between $[Cr(H_2O)_6]^{+3}$ and $[CrO_6Mo_6O_{18}H_6]^{-3}$. This appears to be the first established case of exchange of an intact MO_x unit. The ^{18}O exchanges between solvent H_2O and $[Cr(H_2O)_6]^{+3}$ at a slow but appreciable rate ($t_{\frac{1}{2}}$ = 22.5 hours at conditions used), but the exchange of ^{18}O between solvent and the CrO_6, while it is in $[CrO_6Mo_6O_{18}H_6]^{-3}$, is many times slower if it exists at all. The exchange of CrO_6 units between $[Cr(H_2O)_6]^{+3}$ and $[CrO_6Mo_6O_{18}H_6]^{-3}$ is much faster. Thus the exchange of ^{18}O between solvent H_2O and $[Cr(H_2O)_6]^{+3}$ appears to be greatly slowed by the presence of $[CrO_6Mo_6O_{18}H_6]^{-3}$, because the latter complex provides a place where, at any given instant, part of the CrO_6 units potentially available for ^{18}O exchange with the solvent can "hide" from that ^{18}O exchange. The exchanges of ^{63}Ni between $[Ni(H_2O)_6]^{+3}$ and (1) $[NiO_6Mo_6O_{18}H_6]^{-3}$ and (2) $[NiO_6W_6O_{18}H_6]^{-4}$ were studied, and the exchanges of ^{18}O between solvent and each of those heteropoly complexes were examined. Greatly improved preparative methods were devised for sodium 6-molybdonickelate(II) and for sodium 6-tungstonickelate(II), which give almost quantitative yields. Differential scanning calorimetry data for these complexes confirm the presence of three constitutional water molecules per anion. The exchange data for the Cr complex prove that the coordination number of Cr therein, in solution, is six. An improved combination of procedures for studying ^{18}O exchange between $[Cr(H_2O)_6]^{+3}$ and solvent, or other species, suitable for dilute solutions, is reported. (Diss. Abstr. Int., B)

31936 MECHANISMS OF THERMOLYSIS OF VARIOUS ALLYL ETHERS. Sarner, Stanley Frederick. Newark, Del.; Univ. of Delaware (1970). 134p. University Microfilms Order No. 71-6481.
Thesis.

Experimental techniques were developed for study of gas phase thermolysis kinetics. Instrumentation was constructed, and the apparatus tested using ethyl acetate and dicyclopentadiene. It was found that this technique gave data which was in agreement with literature data, with excellent reproducibility, and in much shorter time than by previous methods. An improved apparatus for the study of liquid phase thermolysis kinetics was also developed. Data were obtained for the thermolyses of methyl allyl ether, ethyl allyl ether, isopropyl allyl ether, deuteroisopropyl allyl ether, and t-butyl allyl ether in both the gas phase and in the liquid phase in various solvents. In addition, gas phase data were obtained for the thermolysis of diallyl ether. The results indicate that these ethers react via a six-membered cyclic transition state to give an elimination reaction yielding propene (1-butene in the case of t-butyl allyl ether) and a carbonyl compound. This latter is formaldehyde, acetaldehyde, acetone, acetone, and acrolein respectively for the thermolyses of the methyl, ethyl, isopropyl, and t-butyl allyl ethers and diallyl ether. The mechanism appears to be uniform for all the ethers studied, and for both the gas and liquid phases. A comparison of the reaction rates and activation parameters of the proteo- and deutero-isopropyl allyl ethers shows a deuterium isotope effect of 60 to 75 percent of the theoretical maximum effect, confirming that the breaking of the C–H bond is involved in the transition state. (Diss. Abstr. Int., B)

31937 MECHANISM OF HYDROGEN–DEUTERIUM EXCHANGE OF 1-METHYL-4-PYRIMIDONE AND RELATED COMPOUNDS AND SYNTHETIC APPROACHES TO A MODEL COMPOUND SUITABLE FOR FIELD EFFECT STUDIES. Watson, Richard Noble. Urbana, Ill.; Univ. of Illinois (1970). 211p. University Microfilms Order No. 71-5271.
Thesis.

The rate constant for hydrogen–deuterium exchange at the 2 position of 1-methyl-4-pyrimidone was obtained at 70°C in D_2O and compared with a calculated rate constant obtained using 1,3-dimethyl-4-pyrimidonium fluoroborate as a model for the protonated intermediate in a prior-protonation mechanism. The agreement between the calculated and observed rate constants, $(4.6 \pm 2) \times 10^{-6}$ and $(9.0 \pm 0.5) \times 10^{-5}$ sec^{-1}, suggests that the prior-protonation mechanism is operative in the exchange of 1-methyl-4-pyrimidone. No rate enhancement was observed in exchanges of this pyrimidone when potential tautomeric catalysts were adde to kinetic solutions. The concerted mechanism was ruled out based on these observations. Attempted exchange of 4-methoxy-1-methyl-pyrimidinium iodide gave only hydrolysis. The second-order rate constant for hydrolysis was a minimum of 7.1×10^4 l/mole-sec. This is an upper limit for exchange at the 2 position, and is much slower than the rate constant of 5.4×10^6 l/mole-sec obtained for 1,3-dimethyl-4-pyrimidonium cation. The comparison of these rates suggested lone-pair repulsive interaction between the electrons of nitrogen and those of a developing carbanion. This result is generalized to include the exchanges of all heteroaromatic compounds possessing lone-pair electrons. A comparison of the rates of exchange at the 6 position of 1-methyl-4-pyrimidone and the 2,6- position of 1-methyl-4-pyridone was made. The similarity in rates indicates a similarity of mechanism for exchange. A comparison of the $J^{13}C-H$ coupling constants and rates of exchange was made for the 2 or 6 positions of 1-methyl-4-pyridone, 1-methyl-4-pyrimidone, 4-methoxy-1-methyl-pyridinium fluoroborate, 1,3-dimethyl-4-pyrimidonium fluoroborate, and 1-methylpyridinium iodide. No correlation could be found between these two quantities. The conclusion is made that, as a general rule, no correlation will be found. The kinetic solvent isotope effects for the H/D exchange at the 2,6 positions of 1-methyl-4-pyridone, 4-methoxy-1-methyl-pyridinium fluoroborate, and 1-methylpyridinium iodide were determined in methanol to be 0.88 ± 0.08, 4.41 ± 0.5, and 0.9 ± 0.1. These results are unexpected and are rationalized in terms of varying degrees of solvent participation in the ionization of the solute C–H bonds. Adduct formation in acidic and basic methanol solutions of 4-methoxy- and 4-ethoxy-thiapyrylium fluoroborate was studied by nmr and uv. The rate constant for hydrolysis of these salts, and the crude rate of exchange of thiapyrylium fluoroborate suggest that adduct formation does cause the spurious rate found previously in the exchange of 4-methoxy-thiapyrylium fluoroborate. The preparation of derivatives of α-hydroxymethylene camphor and of 1,4,4a,5,6,7,8,8a-octahydro-1:4, 5:8-dimethano-naphthalene-6-one are described. No charged derivative of either of these compounds containing a heteroatom was found suitable for further field effect studies. (Diss. Abstr. Int., B)

Physical Chemistry

Refer also to abstracts 31767, 32055, 32809, and 33477.

31938 (KFK-1283) VAPOR PRESSURE MEASUREMENTS ON TRICYCLOPENTADIENYL COMPLEXES OF URANIUM AND SEVERAL LANTHANIDES ACCORDING TO THE EFFUSION

METHOD. Haug, H. O. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). Feb 1971. 23p. (In German). Dep. NTIS (U. S. Sales Only).

Vapor pressures of uranium tricyclopentadienyl chloride, the tricyclopentadienyl compounds of Pr, Nd, Ho, and Tm, and gadolinium dicyclopentadienyl chloride were measured by the effusion method in the pressure range 10^{-2} to 10^{-5} torr and temperatures between 65 and 190°C. The enthalpies of sublimation of these compounds were found to be 27.7; 31.3; 32.2; 28.6; 26.1; and 33.7 kcal/mole, respectively (approximate error ±0.5 kcal/mole). Within the rare earth series the volatility of the tricyclopentadienyl compounds increases with higher atomic number of the metal. (auth)

31939 (ORNL–4648) COMPUTER PROGRAM FOR CALCULATING THE FRACTIONAL DISTRIBUTION OF TRIVALENT ACTINIDE SPECIES IN SODIUM SULFATE–SULFURIC ACID SOLUTIONS. McDowell, W. J. (Oak Ridge National Lab., Tenn.). [1970]. Contract W-7405-eng-26. 20p. Dep. NTIS.

A FORTRAN IV program for calculating the fractional distribution of the trivalent actinide species (M^{3+}, MSO_4^+, $M_2(SO_4)_3$, $M(SO_4)_2^-$, and $M(SO_4)_3^{3-}$) in aqueous sodium sulfate–sulfuric acid solutions is described. A set of desired total sulfate concentrations (maximum, 1.5 M) and a desired sulfuric acid activity may be specified. Solution composition (total sulfate and H_2SO_4 molarity), sulfate ion concentration, and ionic strength are tabulated. Actinide species distribution is tabulated and may be plotted as a function of total sulfate or sulfate ion concentration. (auth)

31940 RAMAN SPECTRA OF SOME β-DIKETONE METAL COMPLEXES. Wiedenheft, C. J. (Monsanto Research Corp., Miamisburg, Ohio). Inorg. Nucl. Chem. Lett.; 7: 439-42(May 1971).

Raman spectra of several octacoordinate Th and Zr β-diketone complexes were studied, and the depolarization ratios and relative intensities were determined. The Th compounds investigated were the acetylacetonate, the 1-phenyl-1,3-hexadionate, the 1,3-diphenyl-1,3-propadionate, and the 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyl-4,6-octadionate; the Zr compounds were the acetyl-acetonate and the 1,1,1-trifluoro-2,4-pentadionate. The relationship between the average Taft constant (average electron withdrawing ability of the R substituent) and the metal-oxygen Raman intensity is shown graphically. The polarizability of the M–O bond, and hence the covalency, is determined by the β-diketone substituent acting through the quasi-aromatic system of the ligand: in the hexafluoroacetylacetonate complex the M–O bond becomes so ionic that it could not be observed in the Raman spectrum. (UK)

31941 POLAROGRAPHY OF THE URANIUM(VI) CHELATE OF TRANS-1,2,-DIAMINOCYCLOHEXANE-N,N,N',N'-TETRA-ACETIC ACID. Lai, Tsai-teh; Kao, Chen-feng (Cheng Kung Univ., Tainan, Taiwan). Anal. Chim. Acta; 54: 521-7(May 1971).

The chelate of uranium(VI) with CDTA was investigated polarographically over the pH range 2.48 to 11.00 and the ligand concentration range 0.02 to 0.20 M. A reversible one-electron reduction wave was obtained for [CDTA] > 0.04 M below pH 7.0. The reversibility of the electrode reduction was favored by higher ligand concentrations and lower pH values. For [CDT ≦ 0.04 M at about pH 6, partial dimerization of the uranium(VI)–and uranium-(V)–CDTA chelates was observed. The electron transfer coefficient and rate constant at 30°C for the irreversible waves were determined. The rate constants of the reaction and the diffusion coefficients of the chelate are given. (auth)

31942 STUDIES IN THE SYSTEM UO_2–ThO_2–O_2. PART I. HIGH TEMPERATURE BEHAVIOUR OF U_3O_8. Momin, A. C.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 8: 926-30(Oct 1970).

The effects of the environmental atmosphere on the high-temperature phases of U_3O_8 and of the exposed surface on the weight loss of U_3O_8 as well as the kinetics of isothermal weight loss of U_3O_8 were studied in the range 1200 to 1500°C. The structural and compositional changes in U_3O_8 are extremely sensitive to the environment during heating as well as cooling. The weight losses of U_3O_8 in air are essentially due to (i) a decomposition reaction that is independent of the exposed surface and that predominates at temperatures below 1250°C, and (ii) vaporization that predominates at higher temperatures and that depends on the area of exposed surface. The weight loss process associated with the vaporization of the decomposition product obeys first order kinetics with an energy and entropy of activation of 104 kcal/mole and 50.5 e.u. respectively. (auth)

31943 STUDIES IN THE SYSTEM UO_2–ThO_2–O_2. PART II. HIGH TEMPERATURE BEHAVIOUR OF U_3O_8–ThO_2 MIXTURE. Momin, A. C.; Karkhanavala, M. D. (Bhabha Atomic Research Centre, Bombay). Indian J. Chem.; 8: 931-5(Oct 1970).

The effect of exposed surface on the weight loss of U_3O_8–ThO_2 mixture and the kinetics of isothermal weight loss from such mixtures were studied in the range 1200 to 1500°C in air. The behavior of U_3O_8–ThO_2 mixture is similar to that observed earlier for U_3O_8 [Indian J. Chem., 8 (1970), 926]. The weight loss process of U_3O_8–ThO_2 mixture follows first order kinetics (energy and entropy of activation of 74 kcal/mole and 16.5 e.u. respectively) but only after a certain initial period. The weight loss during this period follows the parabolic rate law. The kinetics of urania-thoria solution formation, the composition limit and the volatility of solid solution were also determined. The kinetics of solid solution formation obeys Janders equation with an energy and entropy of activation of 41.5 kcal/mole and 6.3 e.u. respectively. The limiting composition (mole %) of the cubic nonstoichiometric solid solution is about 75 UO_2–25 ThO_2 at 1400°C in air. However, this composition limit is expected to change with temperature and time of heating since substantial preferential volatilization of the uranium oxide component from the solid solution was observed. (auth)

31944 POSSIBILITIES OF REDUCING LOSSES IN THE SEPARATION OF TRACE ELEMENTS BY PRECIPITATION. DETERMINATION OF THE RELATIVE STABILITIES OF ADSORPTION COMPLEXES. Upor, E.; Nagy, G. (Mecsek Mining Co., Hungary). pp 227-31 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 1. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.1).

The main problems that influence adsorption of interfering ions on a precipitation system containing metal hydroxides and some complexing agents were studied particularly for the adsorption of UO_2^{2+} from carbonate medium. The extent of adsorption and its pH dependence are different on different metal hydroxides. It was found that relative complex stabilities are characterized by the ligand concentration at which the extent of adsorption reaches 50%, and the following stability order was obtained for UO_2^{2+}: $MnO_2 \cdot nH_2O < Al(OH)_3 < Fe(OH)_3 < Cr(OH)_3 < Ti(OH)_4$. The stability order of carbonato complexes was demonstrated to be: $UO_2^{2+} > Zr(IV) > Th(IV) > Hf(IV) > Sc(III) > Ln(III)$. (B.L.M.)

31945 FORMATION AND THERMAL DECOMPOSITION OF ALKALI URANATES. Poko, Z.; Fodor, M.; Szabo, E. (Central Research Inst. for Physics, Budapest). pp 285-90 of Proceedings of the III. Analytical Chemical Conference, Budapest, August 24–29, 1970. Vol. 2. /Buzas, I. (ed.). Budapest; Akademiai Kiado (1970).

From third analytical chemical conference; Budapest, Hungary (24 Aug 1970). See CONF-700838-(Vol.2).

The change in properties of the hydrated uranates during formation from the basic compound $UO_3 \cdot 2H_2O$ was investigated. Three different methods of production, (1) hydration of UO_3, (2) hydrolysis of uranyl salts, and (3) alkali hydrolysis, were used to produce the hydrated uranates, and each method showed the same product by chemical analysis. However, thermal decomposition led to the conclusion that identical quantities of water were bonded with different bond strengths. The ir spectra of the starting materials, the decomposition products from each preparation, and the deuterization modifications were investigated, and a mode of preparation of the alkali uranates is suggested. (B.L.M.)

31946 SELF-DIFFUSION OF WATER IN URANYL NITRATE HEXAHYDRATE. Franklin, M. L.; Flanagan, Ted B. (Univ. of Vermont, Burlington). J. Phys. Chem.; 75: 1272-8(29 Apr 1971).

The self-diffusion of water in uranyl nitrate hexahydrate (UNH) was investigated by following the course of isotopic exchange with D_2O. The extent of exchange exhibits a square-root dependence on time. This suggests that the slow step is solid-state diffusion. The rate of diffusive exchange of UNH with $H_2{}^{18}O$ is comparable to that with D_2O and therefore the entire water molecule diffuses. The pressure and temperature dependences of diffusive exchange were examined. The temperature dependence can be expressed as $D = 4 \times 10^{-3} \exp(-7600/RT)$. Possible mechanisms for diffusive exchange in UNH are considered. (auth)

31947 STUDIES OF THE SUPEROXIDE ION AND OTHER SOLUTE SPECIES IN MOLTEN FLUORIDES. Whiting, Fred Lee. Knoxville, Tenn.; Univ. of Tennessee (1970). 89p. University Microfilms Order No. 71-7693.

Thesis.

The existence of O_2^- ion in molten LiF–NaF–KF at 500°C was established. The absorption spectrum of O_2^- in molten LiF–NaF–KF at 500°C consists of a band at 254 nm. This is in excellent

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agreement with the spectrum of the transient O_2^- in aqueous solutions and with the spectrum of O_2^- in alkali halide crystals. The spectrum of O_2^- in liquid ammonia was obtained and found to differ from that reported by Thompson and Kleinberg. The band position for the O_2^- ion determined in this investigation is at 252 nm in liquid ammonia. Raman spectral results show the vibrational frequency of the O_2^- ion in molten LiF–NaF–KF to be at 1107 ± 3 cm^{-1}. A novel voltammetric-spectrophotometric technique was employed in an attempt to obtain the spectra of some high oxidation state species in molten LiF–NaF–KF. The species were generated at a microelectrode positioned in the optical aperture of a captive liquid cell. The utility of the method was demonstrated by obtaining a spectrum of U(III) generated by the reduction of U(IV) in molten LiF–BeF_2–ZrF_4 at 540°C. The spectrum of the U(IV)–U(III) mixture is given. The electrochemical studies of the oxidation of Ta(V) in molten LiF–NaF–KF were in essential agreement with the work of Mellors and Senderoff, although this in itself does not constitute a proof for the formation of Ta(VI). Spectral evidence could not be obtained for Ta(VI). No evidence, electrochemical or spectral, was obtained for the existence of Cu(III) in molten LiF–NaF–KF at 500°C. Potassium hexafluorocuprate(III) decomposed when added to the melt. The spectrum of Cu(II) in molten LiF–NaF–KF at 500°C consists of a broad band at 880 nm. Cobalt(III) fluoride was also found to be unstable in molten LiF–NaF–KF at 500°C. Cobalt(III) fluoride decomposed when added to molten LiF–NaF–KF at 500°C; whereas, a solution of CoF_3 in molten KHF_2 at 250°C was obtained, but spectral results were inconclusive due to the turbidity of the melt. The spectrum of Mn(III) in molten LiF–NaF–KF at 500°C was obtained. The spectrum was generated by the addition of MnF_3 directly to the melt and by the electrochemical oxidation of Mn(II) in the melt. The absorption spectrum of Mn(II) in molten LiF–NaF–KF at 500°C consists of a weak band at 408 nm. The CrO_4^{2-} ion was produced in molten LiF–NaF–KF at 500°C by the oxidation of the chromium impurity present in LiF–NaF–KF with oxidants such as CoF_3, MnF_3, NaO_2, Na_2O_2, and O_2. The spectrum of CrO_4^{2-} exhibited bands at 372 and 265 nm. Raman spectral evidence is also reported for CrO_4^{2-} in molten LiF–NaF–KF. A method for the removal of chromium ions, as well as some other metallic ions, from molten fluoride melts is discussed. It consists of treating the melt with silicon metal. Two possible products from the oxidation of silicon metal (Na_2SiF_6 and Na_2SiO_3) were found to be insoluble in molten LiF–NaF–KF. The treatment was effective in removing at least 95% of the chromium which was present originally at a concentration of 7 ppM. (Diss. Abstr. Int., B)

31948 IR-SPECTRA OF $M_2UO_2F_4.H_2O$ COMPLEXES. Sergienko, V. I.; Davidovich, R. L. (Chemistry Div., Academy of Sciences, Vladivostok, USSR). Spectrosc. Lett.; 3: No. 2, 35-42 (Feb 1970).

Frequencies found in $Rb_2UO_2F_4 \cdot H_2O$ and $CsUO_2F_4 \cdot H_2O$ infrared spectra and their assignments were used to obtain a set of vibration frequencies characterizing $M_2UO_2F_4 \cdot H_2O$. A study of $M_2UO_2F_4 \cdot H_2O$ infrared spectra allows certain considerations on the structure of complex anions involved in the composition of the substances. To study the nature of the water bond, infrared spectra of $Rb_2UO_2F_4 \cdot D_2O$ and $Rb_2UO_2F_4 \cdot HDO$ were obtained. (D.P.O.)

31949 ABSORPTION SPECTRUM OF Cs_2NpCl_6. Menzel, E. R.; Gruber, J. B. (Washington State Univ., Pullman). J. Chem. Phys.; 54: 3857-64(1 May 1971).

The absorption spectrum of single crystal Cs_2NpCl_6 was investigated at 4.2, 77, and 300°K. The crystal field-split $5f^3[SL]$–J levels of tetravalent neptunium below 13,000 cm^{-1} in energy are sufficiently separated by spin–orbit interaction to permit a first-order analysis of the crystal field splitting. The crystal field splitting of the ^4I and ^4F states based on the octahedral symmetry of the hexachloro complex was calculated using parameters B_4 = 520 and B_6 = 150 cm^{-1}. The center of gravity of the crystal field-split J levels can be compared with a theoretical "free-ion" calculation for intermediately coupled J levels using the Racah parameters E^1 = 2955, E^2 = 17.4, E^3 = 313.8 in cm^{-1} and a spin–orbit parameter ζ = 1985 cm^{-1}. In comparison with the crystal spectra of hexachloro tetravalent protactinium and uranium, the neptunium crystal-field splitting was smaller by roughly a factor of 2. This observation leads to the idea of an actinide contraction since the crystal structure is similar for all three systems. (auth)

31950 IR-ABSORPTION SPECTRA OF THE $M_3UO_2F_5$ COMPLEXES. Sergienko, V. I.; Davidovich, R. L. (Chemistry Div., Academy of Sciences, Vladivostok, USSR). Spectrosc. Lett.; 3: No. 1, 27-34(Jan 1970).

The frequency values and their assignments for $Na_3UO_2F_5$, $K_3UO_2F_5$, $Rb_3UO_2F_5$, $Cs_3UO_2F_5$, and $(NH_4)_3UO_2F_5$ are given. The influence of the cation size and crystal lattice symmetry of the complexes on the $M_3UO_2F_5$ infrared spectra are discussed. (D.P.O.)

Radiation and Nuclear Chemistry

Refer also to abstracts 31888 and 34070.

Radiation Effects

Refer also to abstract 33407.

31951 ALTERNATING COPOLYMERIZATION OF CARBONYL SULFIDE WITH AZIRIDINES. Yokota, Hisao; Kondo, Masatsune (Central Research Lab., Osaka). J. Polym. Sci., Part A-1; 9: 13-25(Jan 1971).

The copolymerization of carbonyl sulfide with aziridines such as ethylenimine, propylenimine, and N-ethylethylenimine was studied in various organic solvents. The copolymerizations occurred easily without addition of any catalyst and gave white powdery crystalline copolymers. The copolymers produced were insoluble in many organic solvents, but soluble in p-chlorophenol and dimethyl sulfoxide. The elementary analyses and the infrared spectra showed that alternating copolymers that have a thiourethane structure were produced. In the copolymerization of carbonyl sulfide with ethylenimine, both the polymer yield and the molecular weight of the resulting polymer increased with the use of a solvent having a higher dielectric constant, and also with an increase in the ratio of carbonyl sulfide to imine in the feed. The rate of copolymerization of carbonyl sulfide with aziridines was in the order of ethylenimine > propylenimine > and N-ethylethyenimine. Irradiation of the copolymers improved their thermal properties and increased their melting point. (auth)

31952 ELECTRON PARAMAGNETIC RESONANCE STUDY OF Y-TYPE ZEOLITES. III. O_2^- ON AlHY, ScY, AND LaY ZEOLITES. Wang, Katherine M.; Lunsford, Jack H. (Texas A and M Univ., College Station). J. Phys. Chem.; 75: 1165-8(15 Apr 1971).

An attempt was made to study crystal field interactions between adsorbed O_2^- ion and some group III cation-exchanged Y-type zeolites. AlHY, ScY, and LaY zeolites were prepared, broken into chips, and irradiated using a ^{60}Co γ source in the presence of oxygen. EPR spectra were recorded and analyzed to indicate reactions of the O_2^- ion. (M.C.G.)

31953 SOME CHARACTERISTIC VALUES OF FREE ACIDS OF NATURAL FATS AFTER IRRADIATION WITH γ RAYS. Bancher, E.; Washuettl, J.; Spaun, R. (Technische Hochscule, Vienna). Fette-Seifen-Anstrichm.; 73: No. 2, 73-5(1971). (In German).

The alteration of some characteristic values of palmitic, stearic, linoleic, and oleic acids after irradiation with γ rays at 25 to 90 Mrad was investigated. With increasing dose of irradiation the acid value indicated a falling tendency in all cases, whereas the iodine value after γ irradiation showed varying values. Benzidine value, which could be measured at 25 Mrad only, showed a slight increase. At the highest dose of irradiation, peroxide value of saturated and unsaturated fatty acids behaved in a different manner; compared to the value obtained at 40 Mrad, a relatively strong increase was observed with saturated fatty acids and a rather considerable decrease was found with unsaturated fatty acids. The refractive index of oleic and linoleic acids increased steadily, corresponding to the dose of irradiation on individual fatty acids. (auth)

31954 PHOTOANNEALING OF CHEMICAL RADIATION DAMAGE IN POTASSIUM AND CESIUM BROMATES. Dube, J. S.; Mohanty, S. R. (Utkal Univ., Bhubaneswar, India). Radiochim. Acta; 15: 100-1(Mar 1971).

Recovery of damage fragments in γ-irradiated potassium and cesium bromates by light in the visible region was observed. The plot of the logarithm of the concentration of oxidizing fragments against photoannealing time was linear in both cases. (M.C.G.)

31955 DIFFUSION IN IRRADIATED LIQUID SYSTEMS. Terrado, Ernesto Nudo. Charlottesville, Va.; Univ. of Virginia (1970). 121p. University Microfilms Order No. 70-26,632.

Thesis.

By means of a model based on Eyring's absolute rate theory, it is shown that liquid diffusivities in irradiated systems could theoretically decrease as a result of the lowering of activation energies for viscosity and diffusion caused by disruption of intermolecular bonds. A simple mathematical derivation indicates that the diffusivity decrease in dilute systems should be exponential with radiation dose. Experiments were performed using

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liquid systems: benzene–cyclohexane, benzene–methanol and acetone–water. Diffusion coefficients under normal and irradiated conditions were determined by the diaphragm cell method using gamma rays from fission products in a nuclear reactor at shutdown. The systems were irradiated at doses up to the order of 10^7 rads. The results indicate diffusivity decreases in all three systems, and the decreases were greatest for doses in the order of 10^5 rads. A reduction in the decreases was noted at higher doses and is thought to be due to gamma heating effects. The overall results of the experiments confirmed expectations based on the proposed theory. (Diss. Abstr. Int., B)

Radiation Processes

31956 RADIOINDUCED GRAFTING OF ACRYLIC ACID ONTO POLYETHYLENE TEREPHTHALATE. Tealdo, Gian Carlo (Univ., Genoa); Munari, Stelio; Calgari, Sebastiano. Chim. Ind. (Milan); 52: 759-64(Aug 1970). (In Italian).

The radioinduced grafting of acrylic acid onto polyethylene terephthalate (PET) and the effect of some additives on this reaction were studied. The reaction occurs in the complete absence of oxygen. If the grafting reaction is carried out in the presence of air, the specific surface of the matrix and the dose rate assume great importance because of the competitive action between the diffusion of the monomer and the oxygen. Under conditions of not very high vacuum, the reaction with PET takes place only at high dose rate or when the polymer matrix is in the form of film or pellets. EPR studies have shown that only the free radicals are responsible for the grafting reaction, but the compounds originating from the oxygen are not usable. (tr-auth)

31957 RADIOCHEMICAL GRAFTING OF ACRYLIC ACID ON POLYESTER FIBERS. Bonnefis, J. C.; Puig, J. R. (CEN, Saclay, France). J. Appl. Polym. Sci.; 15: 553-70(Mar 1971). (In French).

The direct grafting by irradiation of fibers of ethylene glycol polyterephthalate in contact with aqueous solutions of acrylic acid has been studied under the following conditions: (a) irradiation by ^{60}Co gamma rays between 10,000 and 100,000 rads/hr for doses up to almost 1 Mrad; and (b) irradiation by an electron beam of the impregnated fibers with doses up to about 4.5 Mrad. The experiments using gamma radiation were carried out at temperatures between 0 and 90°C. The influences of the concentrations of the monomer and of the selective inhibitors of homopolymerization made possible the choice of the most satisfactory operating conditions. The initial speed of grafting is a complex function of the applied dose, since it passes through a maximum at about 2.5×10^3 rad/hr at ambient temperature. The speed of grafting, which diminishes with the dose until it is eventually nullified, is an increasing function of the temperature. Two total energies of activation come into play: 5.10 kcal/mole between 0 and 55°C and 1.46 kcal/mole above 55°C. The grafted fibers containing up to 40% of poly(acrylic acid) show interesting properties with respect to taking up moisture, their affinity for dyes, and their static electric properties, whereas their mechanical properties are practically unaffected. The most useful proportions of grafting are in the range 15 to 20%. (tr-auth)

31958 RADIATION CURABLE COMPOSITIONS. Bassemir, Robert W.; Carlick, Daniel J.; Sprenger, Gerhard E. (to Sun Chemical Corp.). U. S. Patent 3,551,246. 29 Dec 1970. Filed 24 Nov 1967.

Photopolymerizing compositions are considerably improved by incorporation of ethylenically unsaturated esters of pentaerythritol, dipentaerythritol, and polypentaerythritols with acrylic, methacrylic, or itaconic acids into the compositions. (Offic. Gaz.)

31959 RADIATION-INDUCED POLYMERIZATION OF N-PHENYLMALEIMIDE PURIFIED BY ZONE MELTING. Ivanov, V. S.; Musienko, L. F.; Sergeeva, N. A. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 145-9(Aug 1970). (In Russian).

Purification of N-phenylmaleimide was carried out on the automatic multizone apparatus of the French firm "Dam." The thermography method was applied as a criterion of purity and the results compared with those obtained earlier on the one-zoning apparatus. This paper reports on the effect of the degree of monomer purity on polymerization by γ radiation in the liquid and solid phases. The complicated character of the polymerization in the solid state is discussed. (auth)

31960 γ-INDUCED ADDITION OF TRIALKYLTIN HYDRIDES TO UNSATURATED ESTERS. Tsurugi, Jitsuo; Iida, Masaru; Nakao, Ren; Fukumoto, Tsugio; Murata, Niro (Osaka Univ.). Bull. Chem. Soc. Jap.; 44: 777-80(Mar 1971).

Gamma-induced hydrostannation of ethyl acrylate, allyl acetate, and vinyl acetate with triethyltin and tri-n-butyltin hydrides was attempted. The hydrostannation of ethyl acrylate and allyl acetate gave the corresponding adducts in almost quantitative yield. (2-Acetoxyethyl)-tri-n-butyltin expected from hydrostannation of vinyl acetate with tri-n-butyltin hydride could not be isolated. However, NMR and IR spectra indicated the formation of the adduct, which was found to decompose into ethylene and tri-n-butyltin acetate. The decomposition of the adduct was discussed in comparison with other adducts. (auth)

31961 GAMMA-RAY INDUCED GRAFT COPOLYMERIZATION OF POLY(ETHYLENE TEREPHTHALATE) WITH ACRYLIC AND METHACRYLIC ACIDS. PART 2. THE INITIATORS OF GRAFTING PROCESSES. Robalewski, Andrzej M.; Stolarczyk, Lech W. (Inst. of Nuclear Research, Warsaw). Nukleonika; 15: 623-30(1970).

The available literature does not provide information, apart from some general suggestions, as to the nature of peroxides formed during radiolysis of poly(ethylene terephthalate) in an oxygen medium. It has been found that at least two species of different thermal resistance are the precursors of radicals initiating grafting reactions. The component of high stability was ascribed to the occurrence of alkyl peroxide groups, and the component of lower stability was most probably due to the occurrence of ozonides. There is no evidence supporting the occurrence of trapped radicals, and the number of hydrogen peroxide groups has been found to be very limited. (auth)

31962 KINETIC ISOTOPE EFFECTS IN THE RADIATION-INDUCED OXIDATION OF ALCOHOLS BY HYDROGEN PEROXIDE IN AQUEOUS SOLUTION. Burchill, C. E.; Thompson, G. F. (Univ. of Manitoba, Winnipeg). Can. J. Chem.; 49: 1305-9(15 Apr 1971).

By using selectively deuterated alcohols it is demonstrated that abstractions from both α and β positions of 2-propanol and ethanol contribute to the overall mechanism for γ radioinduced chain oxidation of these alcohols by hydrogen peroxide. Kinetic isotope effects are measured for abstraction of H by OH from 2-propanol and ethanol at both α and β positions and for the H atom transfer reaction from the alcohol to the β radical. The chain oxidation of methanol shows no primary kinetic isotope effect on substitution of CD_3OH. (auth) (Canada)

31963 RADIATION-INDUCED HIGH-PRESSURE OXIDATION OF PROCESS EFFLUENTS. Case, F. N. (Oak Ridge National Lab., Tenn.); Kau, D. L.; Smiley, D. E.; Garrison, A. W. pp 755-67 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Studies to determine the effects of gamma radiation combined with air or oxygen at high pressures (1500 to 2000 lb/in^2) on textile-mill, paper-mill, and muncipal sewage effluents were conducted. Radioinduced oxidation at high pressure was shown to reduce the pH, biological oxygen demand, and chemical oxygen demand in the effluents studied. The rates of sedimentation of solids in effluents from cotton-textile finishing mills were much improved over that observed with gamma-radiation treatment at atmospheric pressures. Color due to the presence of residual dye compounds in textile effluents was removed from the effluents studied. Color and odor removal from paper-mill waste and municipal sewage were also observed to occur to a much greater extent than when these effluents were treated by gamma radiation only. (auth)

31964 BINARY ORGANIC GLASSES. THE INTERPRETATION OF POLYMERIZATION IN VITREOUS MIXTURES. Spritzer, Charles (CNRS, Meudon, France). J. Chim. Phys.; 68: 340-54(Feb 1971). (In French).

The existence of a heterogeneous structure at low temperature accounts fairly well for the observed radiation-chemical polymerization kinetics of different monomers (MMA, styrene) in paraffin oil. It is shown that at –78°C, polymerization takes place in liquid droplets of supercooled monomer. At –196°C, the monomer crystallizes at concentrations higher than 20% and no polymerization is observed. At concentrations lower than 20% of monomer, the mixture is composed of two glassy phases. Polymerization then takes place after irradiation during the treatment of the samples. (auth) (France)

31965 THERMAL PROPERTIES OF TRIOXANE-1,3-DIOXOLANE COPOLYMERS PREPARED BY SOLID STATE POST-POLYMERIZATION. Kawase, Kaoru (Government Industrial

Research Inst., Nagoya, Japan). Radioisotopes (Tokyo); 20: 185-7(Apr 1971).

The role of 1,3-dioxolane (DOX) in the thermal properties of polyoxymethylene was examined. Thermograms of the polymeric products showed the melting point to be inversely proportional to the amount of DOX in the products. The degree of crystallinity also decreased with the DOX content of the copolymer, and was shown not to be related to the atmosphere of polymerization. No difference in the diffraction angle was observed by the incorporation of DOX into the polyoxymethylenes as shown by x-ray diffraction diagrams. (D.P.O.)

31966 EFFECT OF SPECIFIC SURFACE AREA OF POLYETHYLENE ON GRAFT COPOLYMERIZATION OF METHYL METHACRYLATE ONTO POLYETHYLENE BY PREIRRADIATION METHOD. Wada, Takeshi; Sugo, Takanobu; Takehisa, Masaaki (Japan Atomic Energy Research Inst., Takasaki). Kogyo Kagaku Zasshi; 74: 484-9(Mar 1971). (In Japanese).

Graft polymerization of methyl methacrylate (MMA) onto polyethylene preirradiated by 1-MeV electrons in air was carried out in the vapor phase of MMA to elucidate the effect of the specific surface area of polyethylene on the graft polymerization. The degree of grafting decreased linearly with increases in the specific surface area of radiopolymerized polyethylene, which has specific surface area of more than 20 m^2/g, regardless of the fact that the amount of MMA adsorption on the polyethylene increased with increasing specific surface area. On the contrary, the degree of grafting increased with increasing specific surface of high-density polyethylene, which has specific surface area of less than 2 m^2/g. Kinetic studies of the graft polymerization led to the conclusion that the concentration of initiating radical is lower in the radiopolymerized polyethylene with larger specific surface area, and is lowest in the high density polyethylene with smaller specific surface area. These results indicate that the specific surface area affects the rate of disappearance of initiating radical and the number of sites for initiation reaction. (auth) (Japan)

31967 ELECTRON SPIN RESONANCE STUDY ON PRIMARY PROCESS IN GAMMA-INITIATED SOLID-STATE POLYMERIZATION OF HALOGENATED ETHYLENE BY MEANS OF MATRIX-ISOLATION TECHNIQUE. Nishimura, Hiromichi; Tabata, Yoneho; Oshima, Keiichi (Tokyo Univ.). Kogyo Kagaku Zasshi; 74: 489-94(Mar 1971). (In Japanese).

A matrix-isolation technique was applied to investigate the primary process in γ-initiated polymerization of various monomers. The primary process in the polymerizations of vinyl fluoride, vinylidene fluoride, vinyl chloride, and other related monomers, were investigated by means of this technique. These monomers are known to polymerize more easily than ethylene. In both γ-irradiated pure vinyl fluoride, and vinyl fluoride in xenon matrices, the vinyl radical was observed, although the fine structure was different under different conditions. This is due to the difference in the rate of exchange of hydrogen atoms. In the ESR spectrum of γ-irradiated vinylidene fluoride a broad component was observed, which was assigned to the polymer radical. On the other hand, in γ-irradiated vinylidene fluoride in xenon matrices several sorts of fragment radicals were observed. The vinyl radical was not observed in γ-irradiated vinyl chloride, but radicals containing a chlorine atom were found. From these results the relation between the ESR spectra and the polymerizability of these halogenated ethylenes (including ethylene and tetrafluoroethylene) is discussed. (auth) (Japan)

Radiolysis

Refer also to abstract 32037.

31968 (NP-18784) γ AND α IRRADIATIONS OF AERATED AND DEGASSED SOLUTIONS OF AMERICIUM AND NEPTUNIUM. Pellerin, Joel (Paris Univ. (France). Faculte des Sciences). [nd]. 50p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The effect of gamma and alpha ionizing radiations on aerated and degassed aqueous solutions of neptunium ions was studied. The considerable long term effects observed in the gamma radiolysis of these solutions led to a study of the action of H_2O_2 on Np(IV), (V), and (VI) solutions in 0.8N H_2SO_4 and 0.2N $HClO_4$, and also the Np(V) amphoterization reaction. The absorption spectrum of a Np(IV) peroxide complex in 0.2N $HClO_4$ solution was obtained in particular. The gamma source used was ^{60}Co and the alpha source a 10^{-4} solution of ^{241}Am which led to a study of the autoradiolysis of acid Am(VI) and (V) solutions in the presence and absence of air. Under gamma irradiation in sulfuric solution, solutions of Np(VI) and Np(V) tend towards a mixture of the (VI) and (V) oxidation states. In Np(IV) solutions the presence of the (V) and (VI) oxidation states are also observed. Under alpha irradiation, sulfuric acid solutions of neptunium develop towards a mixture of the (IV) and (V) oxidation states. In perchloric acid solution the reduction of Np(VI) is fast. Under alpha or gamma irradiation, solutions of Np(V) are stable. Aerated solutions of Np(IV) are oxidized with yields identical to those obtained for the oxidation of sulfuric acid Fe(II) solutions. NpO_2^+ ions are poorer scavengers of OH radicals in perchloric acid than in sulfuric acid solution and poorer scavengers of H radicals than NpO_2^{2+}. (France)

31969 (NP-18785) CHEMICAL CONSEQUENCES OF THE REACTION $^{238}U(n,\gamma)^{239}U$ IN SOME URANIUM COMPOUNDS. Ruffenach, Jean-Claude (Strasbourg Univ. (France). Faculte des Sciences). 1970. 58p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The chemical consequences of the (n,γ) reaction on ^{238}U was studied in inorganic salts (nitrate, sulfate), organic compounds (formate, acetate), and some chelates of uranium. The results obtained show that in U(VI) compounds irradiated in the solid state, a large fraction of the uranyl ions resists nuclear recoil. The retention of ^{239}U in the uranyl ion is generally high and the physicochemical reactions which take place during irradiation are many and complex. Uranium-239 appears in more or less oxidized forms according to whether the fragments formed by decomposition of the irradiated samples are more or less oxidizing. Reactions of hydrolysis, oxidation, and isotopic exchange play a leading part. (France)

31970 (NYO-4106-2) ANNUAL REPORT, 1970-71. (Johns Hopkins Univ., Baltimore, Md.). 3p. Dep. NTIS.

The radiation products of thymine were separated into more than 15 compounds. Four of these, 5-hydroxy-5-methylhydantoin, 5-hydroxyhydrothymine, cis-thymine glycol, and trans-thymine glycol, were characterized by ir, uv, NMR, and mass spectra. Cis- and trans-thymine glycols were subsequently synthesized. (D.P.O.)

31971 GAMMA RADIOLYSIS OF TRICHLOROETHYLENE (TCE). Datta, R. K.; Rao, K. N. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 7: 153-8(Feb 1971).

Trichloroethylene has been radiolyzed by γ rays and a number of products have been isolated and their G values determined. HCl is one of the products whose yield is very large at low doses and decreases as the dose increases. A mechanism has been suggested for the formation of HCl and the other products. (auth)

31972 EVEN ELECTRON SPECIES IN THE GAMMA-RADIOLYSIS OF LIQUID HYDROCARBONS. Mittal, J. P. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 7: 279-81(Feb 1971).

An attempt was made to count even-electron positive species (carbonium ions) in gamma-irradiated cyclohexane, cyclopentane, and neohexane by reacting them with negative species produced by benzyl acetate, carbon tetrachloride, or sec-butyl bromide. Iodine was added to prevent radical-radical reactions. The yield of ion recombination products was low (0.12 to 0.25) for cyclohexane and cyclopentane, indicating that carbonium ions are not very important in the condensed-phase radiolysis of saturated normal hydrocarbons. For neohexane, however, a high yield (0.78 to 0.84) was obtained for all three solutes. This is understandable as hyperconjugation operates very strongly in the even-electron carbonium ions, giving maximum stability to tert-butyl carbonium ions. (D.L.C.)

31973 REACTIONS OF COO^- RADICAL-ION WITH M^+ AND M^{3+} STATES PRODUCED IN THE RADIOLYSIS OF AQUEOUS SOLUTIONS. Shastri, L. V. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 7: 283-4(Feb 1971).

During the use of Cu^{2+}, Co^{2+}, Ni^{2+}, and Cd^{2+} ions as electron scavengers in the gamma-radiolysis of aqueous solutions of formates, precipitation of the metals occurred. This is due to the reduction of the M^+ (formed by e^-_{aq} attachment to M^{2+}) by COO^- generated from the formate ion. For $[Cu^{2+}]/[HCOO^-] = 0.33$, efficient deposition occurs, but for a ratio of 20 there is very little deposition, indicating the oxidation of M^{2+} by OH. Preliminary estimates are given of the rate constants of the reactions involved. (D.L.C.)

31974 ELECTRON TRANSFER REACTION IN THE RADIATION CHEMISTRY OF SOME BIOLOGICALLY IMPORTANT DISULPHIDE COMPOUNDS. Lalitha, B.; Mittal, J. P. (Bhabha Atomic Research Centre, Trombay, India). Radiat. Eff.; 7: 159-62(Feb 1971).

It is found that some biologically important organic disulfides behave in an unique way under gamma irradiation when they are

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added in small amounts to the well-known Fricke dosimetry solution. On irradiation, it is noted that addition of these organic solutes reduces the $G(Fe^{+2} \rightarrow Fe^{+3})$ yield instead of the usual increase found in the case of most other organic compounds. It is argued that these compounds behave as sacrificial radiation protective agents. The observation has been explained on the basis of an electron transfer reaction between the disulfides and OH radical. The resulting radical cations of these compounds then dissociate into nonchain propagating species. An attempt has been made to correlate the protective ability of such compounds towards $(Fe^{+2} \rightarrow Fe^{+3})$ system with their biological radiation protective abilities. The electron transfer mechanism also seems to operate into their radiation protective action towards biological systems. (auth)

31975 γ-RADIOLYSIS OF CYSTEINE–CYSTEAMINE DISULFIDE IN AQUEOUS SOLUTION. Purdie, J. W. (National Research Council of Canada, Ottawa). Can. J. Chem.; 49: 725-30(1 Mar 1971).

γ-Radiolysis of a mixed disulfide, cysteine-cysteamine disulfide, in unbuffered aqueous solution (0.3 mM) was investigated in the presence and absence of oxygen. The principal products were the thiols (cysteine and cysteamine), the corresponding sulfinic and sulfonic acids, the symmetrical disulfides (cystine and cystamine) and ammonia. Cystine and cystamine were formed in very high yields in deaerated solution; (G(CySSCy) ~ 15) but addition of oxygen reduced the yield sharply and it was inversely proportional to the oxygen concentration except at very low oxygen levels. In aerated solution G(CySSCy) = 0.8. These observations were attributed to a chain reaction which was suppressed by oxygen: $RS\cdot + R'SSR \rightleftharpoons RSSR + R'S\cdot$ and $RS\cdot + O_2 \rightarrow RSOO\cdot$. In the case of proteins, it was concluded that although chain reactions between RS· radicals and protein disulfide bonds were possible, they should be inhibited by oxygen. (auth) (Canada)

31976 COMPENSATIONAL EFFECT IN THE PULSED RADIOLYSIS OF CRYSTALLINE ICE. Pernikova, T. E.; Kabakchi, S. A.; Shubin, V. N.; Dolin, P. I. (Inst. of Electrochemistry, Moscow). Kinet. Katal.; 11: 1082-3(Jul-Aug 1970). (In Russian).

The kinetics of disintegration of a polaron in neutral crystalline ice was investigated by the method of pulse radiolysis. It was found that the polaron destruction occurs as a result of the parallel occurrence of first- and second-order reactions. (M.C.G.)

31977 ACTION OF ELECTROMAGNETIC RADIATIONS ON PROTEINS. I. IRRADIATION OF BOVINE SERUM ALBUMIN BY GAMMA RAYS. Colson, C.; Fredericq, E. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 56: 960-82(1970).

Bovine serum albumin solutions were irradiated by moderate and high doses of γ rays (1 to 50 Mrads) under air and in vacuo. The uv spectrum was modified between 250 and 325 nm, the absorbance strongly increasing with dose, particularly at 250 nm and a little less in the 280 nm band. This was interpreted as arising from oxidation of the aromatic rings. The variations of viscosity and sedimentation coefficients with dose indicated an unfolding of molecules followed by aggregation. The effects were stronger in air than in vacuo. Chromatographic analysis indicated a progressive destruction of amino acid residues, the most affected being the sulfur-containing ones and the cyclic ones. The effects were stronger in vacuo than in air. An important decrease of levorotation at 589 nm was brought about by irradiation and attributed to destruction of asymmetry, either by direct action on the asymmetric carbons or by modifications of their environment. Enzymic susceptibility to trypsin and chymotrypsin action increased at low doses and decreased at higher doses of irradiation, because of denaturing effects followed by aggregation and destruction of amino acids. Irradiation in the dry state produced different modifications in the uv spectrum. Viscosity and sedimentation data indicated alterations only at very high doses. The extent of amino acid destruction was similar to what happens in solution but results were more uniform. Enzymic susceptibility and optical rotation were slightly affected. Chemically produced OH radicals (Fenton reagent) had very little action on similar properties of serum albumin solutions. The effects of irradiation were grouped into two main classes. First spectral excitation, denaturation and aggregation mostly due to the action of oxidative radicals such as $HO_2^{\cdot}$, that were favored by oxygen; second the destruction of amino acids and the decrease of optical rotation attributed to reducing species such as H· or H_2O^- that would be inhibited by oxygen. (auth)

31978 CHEMICAL EFFECTS OF γ-IRRADIATION OF AQUEOUS SOLUTIONS OF HEPARIN AND KERATAN SULPHATE. Jooyandeh, F.; Moore, J. S.; Morgan, R. E.; Phillips, G. O. (Univ. of Sanford, Eng. Univ. of Alabama, Birmingham). Radiat. Res.; 45: 455-61(Mar 1971).

During γ irradiation of dilute aqueous solutions of heparin and keratan sulfate, acid and reducing products are formed, mainly as a result of attack by OH radicals. Depolymerization to give lower dextrins also occurs without loss of sulfate groups, which results in a decrease in the dye binding ability of the polyanion. Pulse radiolysis was used to measure the rate constants for attack by OH radicals ($k_2 = 4.7 \times 10^8\ M^{-1}\ sec^{-1}$) and e^-_{aq} ($k_2 = 3.0 \times 10^7\ M^{-1}\ sec^{-1}$). Oxygen exerts a protective effect that can be accounted for by the scavenging reaction $e^-_{aq} + O_2 \rightarrow O_2^-$. (auth)

31979 C_2 AND C_2^- SPECTRA PRODUCED BY THE X IRRADIATION OF ACETYLENE IN RARE-GAS MATRICES. Frosch, R. P. (California Inst. of Tech., Pasadena. Univ. of California, Berkeley). J. Chem. Phys.; 54: 2660-6(15 Mar 1971).

The absorption and emission spectra induced by the x irradiation of acetylene trapped in Ar, Kr, and Xe matrices were studied in the visible region. Two transitions of diatomic carbon dominate the spectrum. The $B\ ^2\Sigma_u^+ \rightarrow X\ ^2\Sigma_g^+$ transition of C_2^-, first identified in a matrix by Milligan and Jacox, is present in all three solvents in both emission and absorption. The $A\ ^3\Pi_g \rightarrow X'\ ^3\Pi_u$ Swan-band system of C_2 is present in emission only, and then only in Ar and Kr matrices. This result is consistent with the gas phase ordering of states, which places the $X'\ ^3\Pi_u$ state of neutral C_2 610 cm^{-1} above the ground state. Spectroscopic constants were obtained by making a least-squares fit of the data. Although the deviations from the gas phase ω_e's are 1 to 2% in the ground state of C_2^- and in the upper state of the C_2 Swan system, there can be no doubt of the assignment. The ω_e's of the upper C_2^- state and the lower state of the Swan system differ from the gas-phase values by only 1 to 2 cm^{-1}. Experiments with carbon-13 enriched acetylene confirmed the vibrational assignments. The emission spectra of both molecules are particularly interesting. Emission was observed from the $v' = 4$, $v' = 2$, and $v' = 1$ levels of C_2 indicating that the vibrational lifetime is as long as or longer than the radiative lifetime of the $A\ ^3\Pi_g$ state. The vibrational quantum numbers of the emitting levels were found to depend on the isotopic species involved, but the same vibronic levels emitted in both Ar and Kr matrices indicating that the relaxation process is strongly dependent on the spacing of the vibrational levels but is relatively independent of the phonon structure of the surrounding medium. Vibrational relaxation was also found to be slow in the $B\ ^2\Sigma_u^+$ state of C_2^-. Emission was observed from both the $v' = 1$ and $v' = 0$ levels of this molecule in all three rare gases. The paths of electronic and vibrational excitation and relaxation in both C_2 and C_2^- are discussed qualitatively. (auth)

31980 γ-RADIOLYSIS AND MERCURY-PHOTOSENSITIZED DECOMPOSITION OF ETHYLBENZENE VAPOR. Yamamoto, Yukio; Takamuku, Setsuo; Sakurai, Hiroshi (Osaka Univ.). Bull. Chem. Soc. Jap.; 44: 574-6(Feb 1971).

The product yields of the mercury-sensitized photolysis and gamma radiolysis of ethylbenzene vapor at room temperature are given. The β bond scissions are the major primary process in both cases. However, in γ-radiolysis the $C_7H_7^+$ ions result, while in the mercury-photosensitized decomposition benzyl radicals result. (D.P.O.)

31981 FORMATION OF ETHANE, ETHYLENE, AND ACETYLENE FROM METHANE ON RADIOLYSIS WITH HIGH-INTENSITY ELECTRON PULSES. Hummel, R. W.; Hearne, J. A. (United Kingdom Atomic Energy Authority, Wantage, Eng.). J. Phys. Chem.; 75: 1164-5(15 Apr 1971).

Results by Cahill, Seeler, and Glass (J. Phys. Chem., 71, 4564(1967) showing a C_2H_6 yield very low compared to that obtained at lower dose rates were not confirmed. $G(C_2H_6)$ at the dose rate of 1.33×10^{27} eV g^{-1} sec^{-1} was identical with the value obtained at lower dose rates. G values were also obtained for C_2H_2 and C_2H_4. (M.C.G.)

31982 EFFECTS OF LENGTH OF HYDROCARBON CHAIN ON RADIOLYSIS OF ALIPHATIC THIOCYANATES. Tushurashvili, R. G.; Bichiashvili, A. D.; Nanobashvili, H. M. (Inst. of Inorganic Chemistry and Electrochemistry, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 61: 329-32(Feb 1971). (In Russian).

Low-temperature radiolysis of aliphatic thiocyanates, $C_nH_{2n+1}SCN$, where n = 2, 3, 4, 5, 6, 8, 9, 10, 11, was investigated by the EPR method. Yields of paramagnetic centers in the initial (G_0), as well as in the linear part (G), of the accumulation curves were measured. Dependence of the radiation yield (G) on the alkyl part of the electronic fraction of the thiocyanate molecule was established. Limiting values of radical yields for the thiocyanate with an infinitely long hydrocarbon chain were determined. (auth)

31983 TRAPPED ELECTRONS IN ALKYLAMINE GLASSES AT 77°K. Noda, S.; Fueki, K.; Kuri, Z. (Nagoya Univ., Japan). Chem. Phys. Lett.; 8: 407-8(1 Mar 1971).

Trapped electrons produced in γ-irradiated alkylamine glasses at 77°K were observed by ESR and optical absorption. It was found that a correlation exists between the ESR linewidth and the wavelength of maximum absorption in the optical spectrum. It was also found that the ESR and optical results obtained are related to the type of amine. (auth)

31984 PENTABROMOCYCLOPENTADIENYL RADICAL. Graf, F.; Guenthard, Hs. H. (Swiss Federal Inst. of Tech., Zurich). Chem. Phys. Lett.; 8: 395-8(1 Mar 1971).

Results of pulse radiolysis and photolysis at several temperatures on dilute solutions of C_5Br_6 are reported. Evidence was found for the formation of the symmetrical radical C_5Br_5. The spectroscopic consequences of halogen substitution in the cyclopentadienyl systen can be summarized firstly as a strong increase of the isotropic g-value of the ESR signal that correlates almost linearly with the spin–orbit coupling constant of the substituent, and secondly, as a large shift of the absorption spectrum to longer wavelengths, while the over-all shape is conserved. The formation of an atom-radical complex $[C_5Br_5 \ldots Br]$ in rigid solution is suggested by the behavior of the absorption spectrum as a function of temperature. (auth)

31985 ATOMIC HYDROGEN TRAPPING IN THE IRRADIATED ZEOLITES NH_4Y AND HY. Abou-Kais, Antoine; Vedrine, Jacques C.; Massardier, Jean; Dalmai-Imelik, Gisele; Imelik, Boris (CNRS, Villeurbanne, France). Compt. Rend., Ser. C; 272: 883-6(8 Mar 1971). (In French).

The atomic hydrogen H^0 stabilized in the zeolites NH_4Y and HY, irradiated at 77°K, was studied by ESR. The width of the H^0 lines and their hyperfine separation vary as a function of the initial heat treatment of the sample. Three series of values due to three types of trapping sites were measured. A correlation between one of these sites and those responsible for Brönsted acidity was established. (France)

31986 ELECTRON PARAMAGNETIC RESONANCE IN POLY(METHYL METHACRYLATE) IRRADIATED BY ^{60}Co. Indovina, Pietro L.; Rosati, Alfredo. Ann. Inst. Super. Sanita; 6: 365-75(1970). (In Italian).

An EPR spectral study was performed on free radicals produced in samples of poly(methylmethacrylate) irradiated with γ rays from a ^{60}Co source. The splitting spectroscopic factor was measured at different frequencies and the time dependence of the parameters of the EPR signal was studied; from this, it was concluded that in the irradiated polymer only one type of free radical is formed. An explanation is given of the observed spectrum in terms of the molecular conformation of the radical. (auth)

31987 TEMPERATURE DEPENDENCE OF THE ESR SPECTRUM OF $CO_2^- CF_2CFCO_2^-$ IN IRRADIATED SODIUM PERFLUOROSUCCINATE. Kispert, Lowell D. (Univ. of Alabama, Tuscaloosa); Rogers, Max T. J. Chem. Phys.; 54: 3326-35 (15 Apr 1971).

Electron-irradiated single crystals of sodium perfluorosuccinate show ESR spectra at 300°K characteristic of a single $CO_2^-CF_2CFCO_2^-$ radical, but on cooling below 130°K the spectra show that motion has been frozen out and that the radicals occupy two crystallographically nonequivalent positions. The hyperfine interaction tensors for one α- and two β-fluorine atoms of each radical was determined at 77°K and compared with those of the 300°K radical. The average of the hyperfine tensors for the two radicals at 77°K is shown to be close to the observed tensor for the single radical at 300°K. Motional averaging by oscillation about the central C–C bond is indicated. Crystals of sodium perfluorosuccinate irradiated and observed at 77°K without warming up show the presence of a single radical with a somewhat different orientation in the crystal lattice than the room temperature radical or either of the radicals obtained on cooling the room temperature radical to 77°K. (auth)

31988 RADIATION PROTECTION OF POLY(VINYL CHLORIDE) BY N-METHYL DITHIOCARBAMATE SUBSTITUTION. Nakagawa, Tsutomu; Hopfenberg, H. B.; Stannett, V. (North Carolina State Univ., Raleigh). J. Appl. Polym. Sci.; 15: 474-58(Mar 1971).

The effect of N-methyl dithiocarbamate substitution on the radiation stability of poly(vinyl chloride) (PVC) films was studied. PVC containing between 2 and 11 mole % N-methyl dithiocarbamate (PMD) was irradiated with γ rays from a ^{60}Co source at 40°C and the evolved gaseous products were measured and analyzed with a mass spectrometer. The apparent G values for gas evolution for PMD decreased remarkably. For example, a G value of 0.28 was obtained for PMD that contains 11 mole % dithiocarbamate group compared with a G value of 10.8 for unmodified poly(vinyl chloride). Furthermore, the mass spectrum of the evolved gas from the same PMD sample (PMD-44) with 10 Mrad irradiation showed no hydrogen chloride to be present. The external protection was studied using polymer-blended films of PVC and PMD-44. The stabilization coefficients for internal protection and external protection in polymer blends were calculated. The ESR spectrum of the irradiated PMD-44 showed a strong anisotropy with high g values, which differed significantly from the spectrum of the irradiated PVC. A suggested mechanism for radiation protection of PVC against γ irradiation by the N-methyl dithiocarbamate group is discussed. (auth)

31989 ELECTRON SPIN RESONANCE OF Pd(I). II. γ-IRRADIATED SINGLE CRYSTALS OF K_2PdCl_4 AND $(NH_4)_2PdCl_4$. Fujiwara, Shizuo; Nakamura, Michihiro (Tokyo Univ.). J. Chem. Phys.; 54: 3378-80(15 Apr 1971).

With the use of the electron spin resonance technique, it was confirmed that the Pd(I) complex ion $(PdCl_4)^{3-}$ is formed in γ-irradiated K_2PdCl_4 and $(NH_4)_2PdCl_4$. The chlorine superhyperfine coupling constants and the g values for the Pd(I) complex ion are used to obtain the fractional unpaired spin density in the chlorine 3s and 3p orbitals and the crystal field splittings, respectively. (auth)

31990 EPR OF FREE RADICALS IN AN ADAMANTANE MATRIX. II. THE BENZYL AND AZABENZYL RADICALS. Lloyd, Roger V.; Wood, David E. (Carnegie-Mellon Univ., Pittsburgh). Mol. Phys.; 20: 735-46(Apr 1971).

Benzyl radicals and the isoelectronic azabenzyl radicals were prepared by x irradiation of toluene or picolines in an adamantane matrix and their isotropic EPR spectra observed and analysed. The proton hyperfine splittings were assigned by specific deuteration and by analogy with the benzyl radical. The spin density distribution is strongly affected by nonsymmetrical nitrogen substitution, but is only weakly affected by symmetrical substitution. INDO calculations on the radicals predict only small deviations from the benzyl radical spin density distribution for all of the azabenzyl radicals. However, the trends in the experimental values can be rationalized in terms of the electronegativity difference between carbon and nitrogen and its effect on the molecular orbitals of benzyl radical. Furthermore the observed trend in the g values not only lends support to this view of the structure but also allows estimation of the approximate energy of the first $n\pi^*$ excited states. (auth) (UK)

31991 RADIOLYSIS OF SUBSTITUTED AROMATICS: ISOMER EFFECTS. Weiss, Jerome (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 45: 252-60(Feb 1971).

Ortho-, meta-, and para-isomers of substituted benzenes and toluenes were irradiated in the liquid state. In all cases an isomer effect was found that appears to be related to the relative electronegativity of the substituent group and the carbon atom of the aromatic ring to which it is attached. A Hammett fit of the hydrogen yields indicates that a linear free energy relationship is applicable in radiation chemistry. (auth)

31992 WATER FORMATION IN THE GAS PHASE RADIOLYSIS OF NITROUS OXIDE–HYDROCARBON MIXTURES. Takao, Satoshi; Hatano, Yoshihiko; Shida, Shoji (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: 873(Mar 1971).

The addition of small amounts of hydrocarbons to N_2O caused a sudden decrease in the nitrogen yield and a large increase in the yield of oxygen-containing products, giving respective plateau values. In all cases, H_2O is the major product with small amounts of alcohols or carbon monoxide. (D.P.O.)

31993 INFRA-RED ABSORPTION PROPERTIES OF IRRADIATED POLYETHYLENE. Kim, Young Jun; Lee, Sang Soo. New Phys. (S. Korea); 10: 107-11(Sep 1970). (In Korean).

Pure polyethylene film, 0.08 mm thick, was irradiated with ^{60}Co gamma rays (source intensity = 600 Ci) and the characteristic infrared absorption spectrum of the specimen was obtained in the range of 2.5 to 15.5 microns. A similar spectrum was obtained for the specimen irradiated in a reactor (output = 250 kW). These spectra were analyzed and compared referring to the normal spectrum of the unirradiated polyethylene. The OH absorption band at 2.9 micron and CO absorption band at 5.8 micron in the gamma-irradiated specimen were found to be very prominent. This is due to the thin material exposed under comparatively low-intensity gamma rays for a prolonged period in air; the oxygen diffusing into polyethylene caused an oxidation effect in the specimen. The C = C or vinylene absorption band at 10.3 micron is hardly noticed, whereas background absorption in the 7- to 12-micron range rapidly increases with dose. The specimen irradiated in the reactor has less strong absorption bands at 2.9 and 5.8 microns, again due to shorter irradiation time. This result

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does agree with that of Brockes and Kaiser who used intense electron beam as the mean of irradiation. In this specimen, however, the C = C absorption band is distinct which is due to H atom recoil by neutron and subsequent hydrogen outgassing. (auth)

31994 PULSE RADIOLYTIC INDUCED TRANSIENT ELECTRICAL CONDUCTANCE IN LIQUID SOLUTIONS. PART 4. THE RADIOLYSIS OF METHANOL, ETHANOL, 1-PROPANOL, AND 2-PROPANOL. Fowles, P. (Univ. of Birmingham, Eng.). Trans. Faraday Soc.; 67: 428-39(Feb 1971).

The rate constants and Arrhenius activation energies for the reaction of ROH_2^+ with RO^- in the liquid state were measured for R = CH_3, C_2H_5, 1-C_3H_7, and 2-C_3H_7. The values at 25°C are 7.05×10^{10}, 3.0; 4.59×10^{10}, 4.3; 2.40×10^{10}, 5.9; and 1.50×10^{10} $l.mol^{-1}$ s^{-1} and 7.3 kcal mol^{-1} respectively. Evidence is presented that, for all the solvents studied (a) the rate coefficients for $ROH_2^+ + e_s^-$ are nearly the same as the above, (b) the rate data (including the effect of traces of water) are adequately accounted for by diffusion theory, (c) $\lambda(e_s^-) \approx \lambda(RO^-)$ and (d) g (free-ions) ≈ 2. (auth) (UK)

31995 SPATIAL DISTRIBUTION OF SECONDARY ELECTRONS PRODUCED IN THE γ-RADIOLYSIS OF CYCLOHEXANE. Sato, Shin; Oka, Takefumi (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: 856-7(Mar 1971).

A procedure for deriving the distribution function of secondary electrons in the γ radiolysis of cyclohexane is given and the implications of this function are discussed. (D.P.O.)

31996 ANNEALING OF DAMAGE HYPOCHLORITE IN GAMMA-IRRADIATED SODIUM CHLORATE. Mohanty, S. R.; Pandey, V. M. (Utkal Univ., Bhubaneswar, India). Radiochim. Acta; 15: 152(Apr 1971).

It was found that the damage hypochlorite in γ-irradiated sodium chlorate recovers on heating rapidly, within minutes, by purely a first order process. An activation energy of 8.1 kcal/mole was calculated. (M.C.G.)

31997 ESR SPECTRA OF METHYL RADICALS IN γ-IRRADIATED CRYSTALS OF SODIUM ACETATE $3D_2O$. Janecka, J.; Vyas, H. M.; Fujimoto, M. (Univ. of Guelph, Ont.). J. Chem. Phys.; 54: 3229-30(1 Apr 1971).

The ESR spectrum of $^{13}CH_3$ radicals in a single crystal of sodium acetate with 3 molecules of D_2O of hydration was measured after γ irradiation at 77°K. In nondeuterated crystals, slightly anisotropic linewidths were noticed, and this was improved by partial deuteration of the crystals, revealing a substructure on each CH_3 line. Some explanation of the hyperfine splittings is given. The comparison of the data with the results of other investigators indicates a difference of the order of 1 G for the isotropic hyperfine constants of the proton and ^{13}C couplings of the CH_3 radical. These differences are attributed to the basic difference between a radical undergoing a restricted axial motion and a radical freely tumbling. (B.L.M.)

31998 ELECTRON SPIN RESONANCE STUDIES OF TRANSIENT RADICALS IN AQUEOUS SOLUTIONS. Eiben, K. (Kernforschungszentrum, Karlsruhe, Ger.); Fessenden, Richard W. J. Phys. Chem.; 75: 1186-1201(29 Apr 1971).

ESR spectroscopy was used to examine aqueous solutions of various solutes during steady irradiation with a 2.8-MeV electron beam. Radiolysis was carried out directly in the ESR cavity; the sample was contained in a silica cell of the usual flat design for aqueous samples. Of the three primary radicals from water (H, OH, and e_{aq}^-) only H could be detected by its ESR spectrum, a 503.2-G doublet (but with the low-field line in emission). Reactions of all three primary radicals were studied. As is usual, use was made of selective scavengers (e.g., N_2O for e_{aq}^-, t-butyl alcohol for OH) to help in identifying the source of the various solute radicals. Emphasis was put on the ability of ESR spectroscopy to provide positive identification of radicals. The technique was tested on some well-understood systems and then applied to several more specific problems, some of which were studied by pulse radiolysis. Some of the reactions studied are: abstraction (by OH) from methyl and isopropyl alcohols and acetate, chloroacetate, malonate, and glycolate ions, addition (of H and OH) to benzene and benzoate ion, attachment of e_{aq}^- to acetone and chloroacetate, and electron transfer from $(CH_3)_2\dot{C}OH$ to several nitrobenzene derivatives. It is noteworthy that in only one case (abstraction from $CH_2(COOH)_2$ to form $\dot{C}H(COOH)_2$) were qualitatively different results found for OH reactions than observed for the active species in the $Ti^{3+}-H_2O_2$ system. (auth)

31999 RADIOLYTIC DECOMPOSITION OF CRYSTALLINE INORGANIC SALTS BY RECOIL PARTICLES. III. RADIOLYSIS OF HYDRATED IODATE SALTS IN A NUCLEAR REACTOR. Hasegawa, Kunihiko (Shizuoka Univ., Japan). Nippon Kagaku Zasshi; 92: 207-11(Mar 1971). (In Japanese).

The radiolysis of IO_3^- ion in hydrated iodate salts ($LiIO_3$ n H_2O, $NH_4IO_3 \cdot$ n H_2O crystals) with nuclear reactor radiations was investigated and the decomposition mechanism was discussed. In the case of the nuclear reaction, in which the effects of recoiled particles from $^6Li(n,\alpha)^3H$ and $^{14}N(n,p)^{14}C$ reaction, and of the elastic and inelastic collisions of fast neutrons were predominant, the over-all radiolytic yields ($G = (-IO_3^-)$) did not vary with the content of hydrating water. In the case of ^{60}Co γ rays, the yields increased greatly with an increase in water content. From this fact, it can be assumed that the radicals (H, OH) and hydrated electrons (e_{aq}^-) produced through the radiolysis of water affect largely the radiolysis of these hydrated salts. The iodine yield ($G(I_2)$) was larger than the iodide yield ($G(I^-)$) in the radiolysis of both anhydrous and hydrated ammonium iodate crystals, but in the case of lithium iodate, the situation was opposite. It was assumed that the large yield of iodine in the radiolysis of ammonium salts was attributed to a unique role of NH_4^+ ion in these compounds. (auth)

32000 RADIOLYTIC DECOMPOSITION OF CRYSTALLINE INORGANIC SALTS BY RECOIL PARTICLES. II. RADIOLYTIC DECOMPOSITION OF CRYSTALLINE AMMONIUM IODATE IN A NUCLEAR REACTOR. Hasegawa, Kunihiko (Shizuoka Univ., Japan). Nippon Kagaku Zasshi; 92: 204-7(Mar 1971). (In Japanese).

Crystalline NH_4IO_3 was irradiated with neutrons under several conditions in order to investigate the dependence of radiolytic decomposition yields on fast neutron flux and reactor temperature. Samples wrapped in Cd-foil and unwrapped samples were irradiated at the reactor temperature and at dry ice temperature, and the decomposition yield was determined. The fact that the yield increases to reach a saturated value with increasing radiation time suggests a possibility of some back reactions induced radiolytically to return to the original parent species. The initial 100 eV decomposition (overall) yield for the wrapped sample was 2.3 times as large as one for the unwrapped sample. The fraction of pyrolysis due to the Cd(n,γ)Cd reaction was estimated to be about 36.5% of the overall yield. The decomposition yields of crystalline NH_4IO_3 by fast neutrons and recoil proton due to $^{14}N(n,p)^{14}C$ reaction were 4.58 and 1.73, respectively, taking account of the LET effects of nuclear reactor radiation. (auth)

32001 INVESTIGATIONS OF PARAMAGNETIC CENTERS PRODUCED BY TRITIUM β-PARTICLE IRRADIATION. I. THE Cd(I) CATION IN SINGLE CRYSTALS OF CALCIUM TETRAACETATO CADMIUM(II) HEXAHYDRATE. Eachus, R. S.; Herring, F. G. (Univ. of British Columbia, Vancouver). Can. J. Chem.; 49: 562-7(15 Feb 1971).

The Cd(I) center was produced by both tritium β-particle radiation and by γ radiation. The tritium was introduced as water of crystallization in calcium tetraacetato cadmium(II) hexahydrate in the form of THO. It was found that both forms of irradiation lead to the same center. The orientation of the hyperfine components of the Cd(I) center throws some light on the possible mechanism of its formation. (auth) (Canada)

32002 RADIATION CHEMISTRY OF SATURATED–UNSATURATED HYDROCARBON SYSTEMS. I. PROCESSES OF HYDROGEN FORMATION. Foeldiak, G.; Wojnarovits, L. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung.; 67: 209-19(1971).

The processes leading to hydrogen formation from irradiated mixtures of saturated and unsaturated hydrocarbons are critically discussed. Reactions of the same type, kinetically undistinguishable from one another, were combined into groups, and for the purpose of future kinetic evaluation, representative reactions were selected from each group, which appear to be suitable for characterizing the group as a whole. (auth)

32003 RADIATION CHEMISTRY OF SATURATED–UNSATURATED HYDROCARBON SYSTEMS. II. HYDROGEN FORMATION DURING RADIOLYSIS OF LIQUID C_5–C_8 HYDROCARBON MIXTURES. Wojnarovits, L.; Foeldiak, G. (Inst. of Isotopes, Budapest). Acta Chim. Acad. Sci. Hung.; 67: 221-7(1971).

Hydrogen formation from mixtures of various saturated and unsaturated as well as aliphatic normal and branched-chain saturated hydrocarbons from γ radiation was studied. It was established that the yields cannot be described by a linear mixing rule but are lower than the calculated values in the case of all mixtures studied. The smallest G_{H_2}-decreasing effect is displayed by branched-chain hydrocarbons. Dienes with various bond types and 1,3,5,7-cyclooctatetraene reduce the G values to a larger extent than monoalkenes do. The effect of benzene exceeds that of other unsaturated hydrocarbons only at higher concentrations, otherwise it is lower. In order to compare the efficiencies of various unsaturated hydrocarbons, an arbitrary, concentration-type quantity y was defined, which gives the num-

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ber of formal double bonds in 1 g of the substance, expressed in 10^{21} g^{-1} units. If the G_{H_2} values are plotted against this quantity, the alkane–alkene mixtures can be subdivided into the following groups according to the type of the double bond: monoalkenes, isolated and cumulated dienes; conjugated dienes; aromatic hydrocarbons. The studies revealed that the effects of monoalkenes, isolated and cumulated dienes are identical, while the specific G_{H_2}-reducing influence of conjugated dienes is stronger. It was established that the behaviour of 1,3,5,7-cyclooctatetraene is analogous to that of conjugated dienes and not to that of benzene. (auth)

32004 EFFECTS OF γ-RAYS ON POLY-L-GLUTAMIC ACID AND POLY-D,L-GLUTAMIC ACID IN THE SOLID STATE. Kunikane, Makoto; Sugai, Shintaro (Hokkaido Univ., Sapporo). Biophysik; 7: 205-11(1971).

Poly-L-glutamic acid and poly-D,L-glutamic acid, as models of proteins, were irradiated with ^{60}Co γ radiation in air and under vacuo to examine whether or not the changes caused by the exposure to ionizing radiation depend on the conformations of polypeptides. The G-values (yield of main-chain scissions per 100 eV of energy absorbed) of both polypeptides are approximately equal for irradiation in air, while under vacuo the G-value of poly-D,L-glutamic acid is larger than that of poly-L-glutamic acid. This observation for irradiation under vacuo was ascribed to the stabilizing effect of intramolecular hydrogen bond bridges in poly-L-glutamic acid. It was also found that the α-helical structure of poly-L-glutamic acid is destroyed by exposure to ionizing radiation. (auth)

32005 ELECTRON SPIN RESONANCE STUDY OF THE PRODUCTION , TRANSMISSION, AND DECAY OF FREE RADICALS IN X-IRRADIATED CATALASE. Lindgren, Gordon Edward. Iowa City, Iowa; Univ. of Iowa (1970). 97p. University Microfilms Order No. 71-5785.

Thesis.

The production, transmission, and decay of free radicals in x irradiated, lyophilized catalase were investigated using electron spin resonance. Samples were irradiated with an x-ray machine, (250 KVP, 30 ma, 1.0 mm HVL), without filtration, and measured with an ESR spectrometer. First-order reaction rates were found for the decay in concentration of free radicals irradiated in vacuo and stored in vacuo for 24 hours, on the admission of N_2 or N_2 + H_2S. Higher order kinetics were found on adding H_2S, H_2S + O_2, or O_2. Thirty minutes after the addition of a gas the following relative concentrations of free radicals were found in the catalase samples (the in vacuo control is 100%): 45%, 50%, 60%, 85% and 95% in O_2, O_2 + H_2S, H_2S, N_2 + H_2S, and N_2 respectively. Even though the rates of disappearance of radicals were different, the spectra were strikingly similar in character. This would seem to indicate a common energy transfer process. Resolution of the absorption curves, first integral of the ESR spectra, of evacuated samples into Gaussian peaks, using a Dupont 310 curve analyzer, resulted in two broad lines and a doublet. The doublet, probably due to unpaired spins on the α-carbon in glycine residues, had g = 2.004, a width of only 22 gauss; no low field sulfur "tail" was seen. An unidentified transient peak at g = 1.994 was also seen. The number of "sulfur" radicals was nearly unchanged after 140 hours in vacuo at room temperature while the doublet concentration had fallen to 25% and that of the high field radical to 10%. The radical concentration appeared to increase by about 30% on warming from −176 to 60°C. The spin concentration in samples irradiated in air at 14 ± 3 krad/min increased almost linearly up to 50 minutes, peaked at 75 minutes and decreased to ⅓ of the peak value at 180 minutes. This was probably due to the presence of water and the radical products of water. This appears to lend support to the intermolecular theory of energy transfer proposed by Henriksen. This theory may also be supported by the findings that intermolecular changes, i.e., in gas environments, altered the rate of energy transfer and the lifetime of the radicals. (Diss. Abstr. Int., B)

32006 RADIATION DAMAGE IN CALCIUM PHOSPHATES AND COLLAGEN: AN INTERPRETATION OF ESR SPECTRA. Fisher, B. V.; Morgan, R. E.; Phillips, G. O.; Wardale, H. W. (Univ. of Salford, Eng. Univ. of Alabama, Birmingham). Radiat. Res.; 46: No. 2, 229-35(May 1971).

The low-temperature ESR spectra of γ-irradiated calcium phosphate samples, that are similar in structure and composition to the principal inorganic components of bone and tooth, are interpreted in terms of the radicals PO_4^{-2}, O^-, and H. There are indications in the low-temperature ESR spectra of some γ-irradiated collagenous materials that most of the damage is concentrated randomly along the main peptide chains and that relatively few radicals are formed in the side chains of the amino acid residues. (auth)

32007 SHORT-LIVED TRANSIENTS OF NUCLEIC ACID CONSTITUENTS DURING INDIRECT EFFECTS OF RADIATION. Singh, B. B. (Bhabha Atomic Research Centre, Bombay). pp 211-17 of Macromolecules in Storage and Transfer of Biological Information. Bombay; Department of Atomic Energy (1970).

From Symposium on macromolecules in storage and transfer of biological information; Bombay, India (15 Dec 1969). See CONF-691227.

The indirect effects of radiation on nucleic acids are mainly due to their reaction with radiolytically produced short-lived transients of water. Hydroxyl radicals, hydrogen atoms, and hydrated electrons are of great significance because of their high yields during water radiolysis and high reactivity with purines and pyrimidines. Using ESR spectroscopy it was shown that on reaction with nucleic acid bases hydroxyl radicals and H-atoms add at the 5–6 double bond of pyrimidines or at C8 of purines forming corresponding free radicals. The radioinduced electrons, however, form base-anions which usually are hydrolysed to yield radicals similar to those formed by H-atoms. (auth)

Radioisotope Production

32008 QUANTITIES AND UNITS USED IN THE PRODUCTION OF RADIONUCLIDES BY CHARGED PARTICLE BOMBARDMENT. Svoboda, K. (Nuclear Research Inst., Rez, Czech.); Silvester, D. J. Int. J. Appl. Radiat. Isotop.; 22: 269-70(Apr 1971).

The lack of agreement on the terminology used to express the yields of radionuclides produced by charged-particle bombardment is stated. The most commonly used quantity is the thick-target yield (Y); i.e., the activity produced in a target whose thickness is at least greater than that needed for attenuation of the particle energy below the threshold energy of the appropriate nuclear reaction. There are unsatisfactory aspects to the use of Y which are discussed and alternatives have been suggested. The problem was considered at the International Conference on the Uses of Cyclotrons in Chemistry, Metallurgy, and Biology at Oxford in September 1969 and various proposals made there are given. However, it was decided to continue the discussion concerning the introduction of a new quantity and the units in which it should be expressed in writing and opinions are requested. (UK)

32009 RAPID MILKING METHOD FOR THE PREPARATION OF ^{224}Ra FROM ^{228}Th SOLUTION. Rajtora, J.; Malatova, I. (Inst. of Radiation Hygiene, Prague). Radiochem. Radioanal. Lett.; 6: 227-36(24 Apr 1971).

A simple and reliable method for the separation of ^{224}Ra from a ^{228}Th solution is described. The method enables ^{224}Ra to be obtained repeatedly with a ^{228}Th contamination not exceeding 0.1% of the ^{224}Ra activity. (auth)

32010 PREPARATION OF CARRIER-FREE ^{129}Cs, ^{132}Cs, AND ^{136}Cs. O'Brien, H. A.; Hupf, H. B. (Oak Ridge National Lab., Tenn.). Int. J. Appl. Radiat. Isotop.; 22: 95-102 (Feb 1971).

Carrier-free ^{129}Cs was produced from enriched ^{130}Ba by a combination of the (p,2n), (p,pn), and (p,2p) reactions. An upper limit of about 8 mCi of ^{129}Cs per hr could be produced from 100-mg ^{130}Ba targets. A half-life study of the ^{129}Cs product revealed a value of 33.3 ± 0.06 hr. Carrier-free ^{132}Cs was produced in a nuclear reactor by the $^{132}Ba(n,p)^{132}Cs$ reaction. The fission-neutron cross section for this reaction was determined to be 2.6 ± 0.4 mb. Cesium-136 was prepared in a nuclear reactor by the $^{136}Ba(n,p)^{136}Cs$ and $^{139}La(n,\alpha)^{136}Cs$ reactions. The fission-neutron cross sections were determined to be 4.5 ± 0.9 and 0.4 ± 0.2 μb, respectively, based on a value of 61 mb for the $^{54}Fe(n,p)^{54}Mn$ reaction. Based on the results obtained in this study it is concluded that usable quantities of carrier-free ^{136}Cs cannot be prepared in a nuclear reactor. (auth) (UK)

32011 THICK-TARGET YIELD FOR THE PRODUCTION OF ^{87}Y BY THE IRRADIATION OF NATURAL RUBIDIUM CHLORIDE WITH ALPHA PARTICLES. Steyn, J.; Meyer, B. R.; Baraendsma, J. M. J. (National Physical Research Lab., Pretoria). Int. J. Appl. Radiat. Isotop.; 22: 85-8 (Feb 1971).

A method is described for standardization of the nuclide ^{87}Y, based on 4π x-gamma coincidence counting with the use of an internal liquid scintillation counter as 4π detector. The thick-target yield for the production of ^{87}Y by irradiation of natural rubidium chloride with 32 MeV α particles was measured as 174 μCi/μA-hr at the peak of the ^{87}Y growth/decay curve after a 3-hr bombardment. (auth) (UK)

32012 PRODUCTION OF HIGH PURITY ^{66}Ni. Pinajian, John J. (to United States Atomic Energy Commission). U. S. Patent 3,573,165. 30 Mar 1971. Filed 10 Mar 1969.

A method was provided for production of high-purity ^{66}Ni by a double neutron capture reaction with enriched ^{64}Ni in a neutron flux in the excess of about 2×10^{15} n/cm^2 · sec. The high energy (1.038 MeV) gamma radiation from the daughter ^{66}Cu makes the ^{66}Ni a very useful isotope in numerous tracer diffusion studies and related investigations, as in metallurgical research. (Office. Gaz.)

Recoil Production and Reactions

Refer also to abstracts 32031 and 32032.

32013 (AERE-R-5842) HOT ATOM CHEMISTRY AND RADIATION DAMAGE ARISING FROM THE (n,γ) PROCESS IN SOLIDS. PART I. FOCUSED COLLISION SEQUENCES AND THE INFLUENCE OF THE CLOSE-PACKED CRYSTALLINE LATTICE ON RECOILS IN POTASSIUM IODIDE. PART 2. IMPORTANCE OF INTERNAL CONVERSION. Cairns, J. A.; Thomson, S. J. (Atomic Energy Research Establishment, Harwell (England)). Jul 1968. 28p. Dep. NTIS (U. S. Sales Only).

Events following (n,γ) reactions in close-packed crystalline solids were investigated. The object is to clarify certain aspects of hot-atom chemistry by utilising current concepts of radiation damage theory. The system chosen for study was potassium iodide, in the form of single crystals. It is shown how (n,γ) reactions involving the iodine atoms should lead to a series of focused collision sequences in the anion lattice, causing ejection of atomic iodine from the crystal surfaces in certain preferred directions. The problem of detecting these chemically minute amounts of recoiled iodine was solved by having the potassium iodide surfaces labeled with ^{131}I. It was demonstrated that ejection of iodine atoms from the surfaces of single crystals of potassium iodide is preferentially initiated by thermal neutrons, as predicted, and is accompanied by modest lattice damage, in agreement with the proposed mechanism. The importance of these observations is to emphasize the ability of the ordered crystalline lattice to reduce the amount of expected radiation damage. This then leads to an examination of some results in the field of hot atom chemistry. It is shown how an extension of this mechanism may account for differences in retentions in various systems, their susceptibilities to subsequent annealing, and even their preservation of optical stereospecificity on irradiation. The results were subjected to quantitative examination. An explanation based solely on the energy released on prompt gamma emission following thermal neutron absorption by ^{127}I is insufficient to generate a large enough number of collision sequences to account for the high yields of recoiled iodine. Internal conversion by ^{128}I can initiate a sequence of events consistent with the mechanism proposed. This approach, therefore, provides information that would not emerge from methods involving measurements of retention. (auth)

32014 RECOIL TRITIUM REACTIONS WITH PROPENE IN THE GAS PHASE. Mahan, Kent I. (Southern Colorado State Coll., Pueblo); Garland, John K. J. Phys. Chem.; 75: 1031-6 (15 Apr 1971).

The recoil tritium–gas phase propene system was studied over a total pressure range from 79 to 511 torr. A decreasing HT/C_3H_5T ratio was observed with increasing pressure from both unscavenged and O_2–scavenged samples. This effect was attributed to decreasing recoil loss with increasing pressure lowering HT production at the wall. The yield of C_3H_5T from different sources was estimated to be 28% via the hot T for H substitution reaction, 56% from excited propyl-t radical decomposition, and 16% via thermal radical routes in the unscavenged system. The radical environment indicated that the formation of dimeric products from the combination of radicals produced by radiation damage and labeled radicals in thermal equilibrium with their surroundings could be important. However, the absence of any of the unsaturated hexene-t's in the gas phase indicated that most of the excited radicals produced by the addition of T to the double bond were removed from the system by decomposition or reaction with propene molecules before reaching thermal equilibrium. (auth)

32015 SUPER HOT ZONES BY NUCLEAR RECOIL IN AMINE-COMPLEXES OF Co, Rh, AND Ir? Roessler, K.; Otterbach, J. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta; 15: 103-4(Mar 1971).

Studies by Gardner et al. on a "hot spot" model for chemical effects of nuclear transformations in solids were carried out by examining consequences of (n,γ) reactions in complexes of the type $[Me(NH_3)_5Cl]Cl_2$ and $[Me(trien)Cl_2]Cl$ (Me = Co, Rh, Ir) that were specifically labeled with ^{36}Cl, ^{60}Co, and ^{197}Ir. A significant effect from radiochemical impurities was investigated. It was concluded that the experimental techniques applied by Gardner et al. cannot lead to unambiguous results for the ^{36}Cl distribution. (M.C.G.)

32016 REACTIONS BETWEEN FISSION PRODUCT ATOMS AND METAL ACETYLACETONATES IN THE SOLID STATE. II. Meinhold, H.; Reichold, P. (Hahn-Meitner-Institut, Berlin). Radiochim. Acta; 15: 76-9(Mar 1971). (In German).

Mixtures of uranium dioxide and metal tris-acetylacetonates were irradiated with neutrons. Afterwards, some of the iodine recoil atoms produced through the fission of uranium were separated from the mixture as labeled metal tris-acetylacetonates. It was shown by the example of the scavenger compound $Co(C_5H_7O_2)_3$ that fission iodine is incorporated in the organic ligand through hydrogen substitution. This mostly generates the product iodated in an acetylacetonate ring on the central carbon atom $(C_5H_6IO_2)Co(C_5H_7O_2)_2$. The labeling yields of different metal tris-acetylacetonates were between 44 and 49%. Labeling cannot be explained as the consequence of a hot reaction but occurs similar to a conventional chemical iodation reaction. (auth)

32017 RECOIL CHEMISTRY OF ^{19}O IN WATER RADIOLYSIS UNDER REACTOR IRRADIATION. Baertschi, P.; Blaser, W. (Eidgenoessisches Institut fuer Reactorforschung, Wuerenlingen, Switzerland). Radiochim. Acta; 15: 59-65(Mar 1971). (In German).

The high enrichment of ^{19}O in radiolytic oxygen produced by reactor irradiation of pure water was investigated. The reaction $^{18}O(n,\gamma)^{19}O$ generates a hot ^{19}O atom, which reacts with the radiolytic species of its own spur such as H and OH. By means of a water irradiation loop with He-stripping and O_2-feed it was found that about 70% of the ^{19}O atoms are leaving their spurs as molecular structures $-{}^{19}O-O-(H_2{}^*O_2, H{}^*O_2, {}^*O_2)$ and thus may lead to gaseous $^{19}O-O$. The reactions of the ^{19}O are discussed in connection with the radiation chemistry of water. (auth)

32018 ANNEALING OF RECOIL EFFECTS IN Co(III) COMPLEXES: A NEW HYPOTHESIS ON THE ROLE OF AMBIENT GASES. Venkateswarlu, K. S.; Kishore, K. (Bhabha Atomic Research Centre, Trombay, India). Radiochim. Acta; 15: 70-6 (Mar 1971).

Oxygen was found to enhance thermal annealing of recoil damage and solid state isotopic exchange in potassium dinitro diglycinato Co(III) and sodium cobalt(III)EDTA · 4 H_2O. This is in contrast to the earlier observations on trisacetylacetone Co(III) and bissalicyldehyde triethylene tetramine Co(III) chloride hydrate, where oxygen was found to inhibit thermal annealing. The observations were interpreted as due to the formation of adducts between the ambient gases and Co(II) chelates similar to synthetic oxygen carriers. An attempt was made to understand on the basis of this new hypothesis, almost all of the divergent data available on the recoil chemistry of cobalt(III) complexes. (auth)

32019 NUCLEAR RESONANCE FLUORESCENCE AND CHEMISTRY OF HOT ATOMS. Adloff, J. P. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta; 15: 135-41(Apr 1971). (In French).

The photons emitted on the de-excitation of nuclear levels populated by radioactive decays can be resonantly scattered under proper conditions. Nuclear resonance fluorescence experiments can lead to informations on the velocity distribution of recoil atoms, the chemical modifications ensuing transmutations, and the slowing down process of hot atoms. (auth)

32020 ANNEALING REACTIONS IN COBALT PHTHALOCYANINE: INFLUENCE OF EXTERNAL ATMOSPHERES. Scanlon, Michael D.; Collins, Kenneth E. (State Univ. of New York, Buffalo. Western New York Nuclear Research Center, Buffalo). Radiochim. Acta; 15: 141-5(Apr 1971). (NYO-3941-4).

Thermal annealing studies were carried out on α- and β-cobalt phthalocyanine under oxygen, nitrogen, hydrogen, or vacuum. Oxygen atmospheres inhibit annealing and promote decomposition of the parent compound. Exposure to a hydrogen atmosphere either before or after introduction of cobalt recoil atoms by neutron activation slightly enhances the thermal annealing of the α-crystals and greatly enhances that of the β-crystals. The different annealing behaviors of cobalt recoil atoms in α- and β-cobalt phthalocyanine are discussed in terms of the different affinities of these crystal forms for absorption of oxygen. (auth)

32021 ISOTOPE EFFECTS IN THE SUBSTITUTION REACTION OF 2.8-eV TRITIUM ATOMS WITH METHANE. Chou, C. C.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Phys. Chem.; 75: 1283-9(29 Apr 1971).

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The relative yields of the substitution reactions of 2.8-eV tritium atoms decrease by a factor of 7.2 for CH_3T from CH_4 to 1.0 for CD_3T from CD_4 in competitive experiments. The ratio of the intramolecular competition for substitution of T-for-H vs. T-for-D in partially deuterated methanes is approximately 1.0. The results are consistent with a primary replacement isotope effect of 1.6 ± 0.2 favoring the substitution of H over D and a secondary isotope effect of 1.6 ± 0.2 per H/D favoring bond formation to a methyl group with more H atoms in it. The characteristics are discussed of the pseudocomplexes existing during the simultaneous presence near the central C atom of five hydrogenic substituents including the energetic tritium atom. The substitution process is inadequately described by a three-particle T−H−R model and instead involves appreciable motion of all of the hydrogenic substituents. (auth)

32022 COMPLETE RETENTION OF CONFIGURATION DURING THE REPLACEMENT OF HYDROGEN BY ENERGETIC TRITIUM IN dl- AND meso-$(CHFCl)_2$. Palino, G. F.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(04-3)-34. J. Phys. Chem.; 75: 1299-1305(29 Apr 1971).

The stereochemistry of the substitution of energetic tritium for H was studied with dl- and meso-$(CHFCl)_2$. In the gas phase, the direct substitution reactions proceed with >99% retention of configuration at the asymmetric carbon atoms. No positive evidence was found for the existence of a direct gas-phase substitution mechanism for T-for-H with inversion of configuration. The "inversion" products are formed from radical combination reactions in experiments without scavenger in the gas phase or with I_2 as scavenger in the liquid phase. Comparison of the relative T-for-H yields indicates that substitution in CH_4 is consistent with results for other molecules such as $Si(CH_3)_4$, $(CH_3)_3CH$, etc. By this indirect comparison, the inversion mechanism is postulated to occur with negligible yield for CH_4 despite the small mass of each substituent. (auth)

32023 SEPARATION OF ^{137}Cs AND ^{137m}Ba BY RESIDUE ABSORPTION. Kirby, H. W. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-GEN-53. J. Chem. Educ.; 48: 269(Apr 1971).

Cesium-137 can be separated from its 2.6-min daughter ^{137m}Ba by the principle of residue adsorption using the difference in solubilities of $Ba_3(PO_4)_2$ and Cs_3PO_4. After a single residue adsorption, ~90% of the ^{137}Cs was in one vessel while 60 to 70% of the ^{137m}Ba was in another. The procedure is described in detail. (B.L.M.)

32024 CHEMICAL FORMS OF SULFUR PRODUCED BY THE $^{36}S(n,\gamma)^{37}S$ REACTION IN AMMONIUM SALTS. Meyer, J. P. (Centre de Recherches Nucleaires, Strasbourg). Radiochim. Acta; 15: 88-92(Mar 1971). (In French).

The chemical forms of ^{37}S produced by the $^{36}S(n,\gamma)$ reaction on ammonium salts, in the solid state and in aqueous solution, were determined. The results were compared with those of ^{37}S formed by the (n,p) reaction on alkali chlorides; they show that the final chemical state of the radiosulfur is independent of the recoil velocity. (auth)

32025 RETENTION OF CONFIGURATION DURING ENERGETIC SUBSTITUTION OF ^{18}F FOR F AT ASYMMETRIC CARBON ATOMS. Palino, G. F.; Rowland, F. S. (Univ. of California, Irvine). Radiochim. Acta; 15: 57-9(Mar 1971).

The gas phase substitution of energetic ^{18}F for one F atom in $(CHFCl)_2$ proceeds with retention of configuration with both the dl and meso molecules as target. The absence of evidence for substitution with inversion of configuration (<10%) is in agreement with earlier gas phase studies of the energetic substitution of T for H in several target molecules, and ^{38}Cl for Cl in 2,3-dichlorobutane. (auth)

32026 CHEMICAL EFFECTS OF NEUTRON IRRADIATION IN p-BROMOCHLOROBENZENE AND p-DIBROMOBENZENE. Halpern, A. (Kernforschungsanlage, Juelich, Ger.). Radiochim. Acta; 15: 83-8(Mar 1971).

The distribution of ^{82}Br among various products arising from the $^{81}Br(n,\gamma)^{82m}Br(IT)^{82}Br$-process in liquid (unscavenged and 1 mole % of Br_2 containing) and solid p-bromochlorobenzene and in solid p-dibromobenzene was studied. Thermal annealing in both solid substances was also investigated. Scavenger, phase, and dose-rate effects are reported. (auth)

32027 STUDY OF THE ROLES OF CHEMICAL FACTORS IN CONTROLLING THE YIELDS OF SUBSTITUTION REACTIONS BY ENERGETIC TRITIUM ATOMS. ELECTRONEGATIVITY, ELECTRON DENSITY, AND BOND ENERGY. Tang, Yi-noo; Lee, Edward K. C.; Tachikawa, Enzo, Rowland, F. S. (Univ. of California, Irvine). Contracts AT(11-1)-407; AT(11-1)-34. J. Phys. Chem.; 75: 1290-8(29 Apr 1971).

The relative yields of the T-for-H substitution reactions by nuclear recoil tritium atoms were measured for various halomethane and alkane molecules under equivalent conditions of tritium atom flux. After the application of corrections for secondary decomposition of primary products, the yield of the T-for-H reaction with CH_3X decreases smoothly with the increasing electronegativity of the substituent X, as measured by the NMR shifts. No evidence was found in support of the hypothesis that halogen substituents interfered sterically with the T-for-H substitution reaction. The relative yields of the T-for-X reaction in CH_3X increase as much as a factor of 7.5 from CH_3F to CH_3I. The most important factor in controlling this variation in yield with the substituent X is the bond dissociation energy of the C−X bond. The sensitivity of both T-for-H and T-for-X substitution reactions to "chemical" factors such as electronegativity and bond strength demonstrates that models for these reactions based only on geometric physical factors such as atomic masses and sizes, bond angles, angle of attack, etc., are seriously inadequate. (auth)

32028 BOND ENERGY EFFECTS IN SUBSTITUTION REACTIONS OF ^{18}F ATOMS WITH METHYL HALIDES. Small, Thomas; Iyer, R. Subramonia; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem.; 75: 1324-6(29 Apr 1971).

The relative yields of the substitution reactions of recoil fluorine-18 atoms with methyl halides increase markedly with decreasing C−X bond strength. The incremental absolute yield of $CH_3{}^{18}F$ detected by comparison of scavenger experiments with HI vs. O_2 is little changed from CH_3F to CH_3I and is therefore fractionally less important in the overall $CH_3{}^{18}F$ yields for the heavier halogen atoms. (D.P.O.)

Radiochemistry

Refer also to abstracts 31888, 32001, 32019, 32026, 32061, 32471, and 32473.

32029 CHEMICAL EFFECTS OF THE ISOMERIC DECAY OF ^{127m}Te AND ^{129m}Te IN AQUEOUS SOLUTION. Hillman, Manny; Weiss, Allen J. (Brookhaven National Lab., Upton, N. Y.). Radiochim. Acta; 15: 79-83(Mar 1971).

Chemical effects of the isomeric transition of ^{127m}Te and of ^{129m}Te were investigated. The parent nuclides were present as either tellurium(IV), tellurium(VI) monomer, or tellurium(VI) polymer. The products were identified as both tellurium(IV) and tellurium(VI). Unlike the decay of ^{132}Te to ^{132}I, no differences were observed in the yields of the products from the monomeric and polymeric tellurium(VI). No differences were observed between the two isotopes. The yield of tellurium(IV) decreased and correspondingly the tellurium(VI) yield increased with increasing p_H. Higher yields of tellurium(VI) were obtained in the presence of oxygen than in the absence of oxygen. Since air does not oxidize tellurium(IV) under the experimental conditions used, an easily oxidizable intermediate must have been formed. The yields were also dependent on the oxidation state of the parent, higher yields of tellurium(IV) coming from the tellurium(IV) parent. This memory effect indicates that the molecules in an aqueous solution are not completely destroyed by the Auger effect. (auth)

32030 CONTRIBUTION TO THE HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY OF URANIUM ORES. Coote, G. E. (Inst. of Nuclear Sciences, Lower Hutt, New Zealand); Whitehead, N. E.; Cohen, N. E. N. Z. J. Sci.; 13: 610-22(Dec 1970).

A Ge(Li) spectrometer with 2-keV resolution was used in the study of γ spectra from U ores. Assignments of γ rays and K x rays were established by energy measurements and chemical separations. Uncontaminated peaks suitable for tracer applications are obtained from ^{235}U, ^{234}Th, ^{214}Pb, and ^{210}Pb. A peak at 186 keV, which is derived from both ^{235}U and ^{226}Ra, can be used in conjunction with the 295- or 352-keV peaks from ^{214}Pb to provide a simple method for determining the $^{238}U/^{226}Ra$ activity ratio, which is independent of the particular detector used, and (in the case of the 352-keV peak) is still valid if the Th series is also present. (auth)

32031 CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS OF BROMINE IN Br_2–CCl_4 SOLUTIONS. Robinson, Gerald Dean Jr. Buffalo; State Univ. of New York (1970). 149p. University Microfilms Order No. 71-7214.

Thesis.

The chemical effects $^{79}Br(n,\gamma)^{80m}Br$, $^{82m}Br(I.T.)^{82g}Br$, and

successive $^{81}Br(n,\gamma)^{82m}Br(I.T.)^{82g}Br$ nuclear transformations in the Br_2-CCl_4 system were studied by measuring the dependence of total organic yield and individual organic product yields upon the concentration of added scavenger Br_2. The effects of the $^{80m}Br(I.T.)^{80g}Br$ transformation were studied by measuring only total organic yields. The transformations were allowed to occur in degassed Br_2-CCl_4 samples of varying composition. Organic yields were determined by adsorption of inorganic radiobromine on $K_4Fe(CN)_6$. Individual organic products were trapped after separation by gas chromatography. The organic yields for all transformations showed a strong qualitative similarity in their dependence on scavenger Br_2 concentration and were found to be somewhat unique in that nonlinearity was observed throughout the entire Br_2 concentration range. Organic yields due to the pure isomeric transitions were twice those of the pure (n,γ) transformation. Individual organic product yields were found to be essentially identical for all of the transformations studied, with yields of multibrominated polyhalomethanes being markedly higher than statistically predicted, especially at the lower Br_2 concentrations. Nonlinearity of the organic yield scavenger curves is discussed in terms of incomplete scavenging of radiobromine, while the unexpectedly high yields of multibrominated polyhalomethanes in dilute Br_2-CCl_4 solutions is treated by comparison with a statistical model. A mechanism for the chemical effects of the $^{79}Br(n,\gamma)^{80m}Br$, $^{80m}Br(I.T.)^{80g}Br$, $^{82m}Br(I.T.)^{82g}Br$, and successive $^{81}Br(n,\gamma)^{82m}Br(I.T.)^{82g}Br$ nuclear transformations in the Br_2-CCl_4 system, which involves uniquely poor efficiency of scavenging of radiobromine by Br_2 in CCl_4 is presented. (Diss. Abstr. Int., B)

32032 HOT ATOM CHEMISTRY OF ORGANIC HALIDES IN SOLUTION. Gennaro, Gerald Peter Jr. Buffalo; State Univ. of New York (1970). 113p. University Microfilms Order No. 71-6068.

Thesis.

The yields ("parent retention") of radioactive carbon tetrabromide in a number of dilute ethanol solutions of carbon tetrabromide following nuclear transformation of bromine atoms were determined. The parent retentions were found to be influenced by a number of factors. Analyses involved precipitation separation and vacuum sublimation purification. A technique for measuring the retention resulting from isomeric transition of ^{80m}Br, based on numerical analysis of nuclear growth and decay curves, was developed. A method for detecting radioactivity from the decay of ^{80}Br without interference from ^{82}Br is described. The retention following isomeric transition is much higher (5%) than that which accompanies radiative thermal neutron capture (0.2%), the low recoil energy associated with isomeric transition accounting for a greater probability of molecular survival than the larger recoil kinetic energy associated with radiative thermal neutron capture. Different solvent alcohols were found to influence the magnitude of the retention in dilute solutions, probably due to a caging effect. Retentions increased in the order: methanol, ethanol, and propanol. The retention was strongly dependent on carbon tetrabromide concentration in the range 3×10^{-4} to 100×10^{-4} mole fraction; but, the retention was concentration independent below these values. Furthermore, the addition of a radical scavenger (iodine) had a marked effect at higher carbon tetrabromide concentrations. These observations are discussed in terms of several mechanisms by which radioactive carbon tetrabromide may be formed. (Diss. Abstr. Int., B)

Separation Processes

Refer also to abstracts 31765, 31875, 31888, 31939, 32200, and 34376.

32033 (BM-RI-7524) DIFFERENTIAL EXTRACTION OF RARE-EARTH ELEMENTS IN QUATERNARY AMMONIUM COMPOUND-CHELATING AGENT SYSTEMS. Bauer, Donald J.; Lindstrom, R. E. (Bureau of Mines, Reno, Nev. Reno Metallurgy Research Center). Jun 1971. 16p.

Solvent extraction separation of light rare earths in a quaternary ammonium compound–chelating agent system was demonstrated in single-stage studies. Typical separation factor values obtained were 93 for lanthanum–praseodymium, 5.4 for praseodymium–neodymium, and 11.6 for neodymium–samarium. These values are significantly higher than those obtained using organophosphate extractants. Further studies in a 20-stage countercurrent mixer-settler resulted in the production of 99% lanthanum (oxide basis) at 96% recovery. Subsequently, 88% of the neodymium with a purity of 92% was recovered in the raffinate. (auth)

32034 (BNWL-1557) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, November 1970–January 1971. Blasewitz, A. G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1971. Contract AT(45-1)-1830. 15p. Dep. NTIS.

Research and development activities in the field of radioactive wastes are summarized. Included are the tabulated data obtained from 33 radioactive demonstration runs in WSEP. The performance of the auxiliary process systems during the rising level glass run was typical of the previous pot calcination runs. Core-drilled samples from four WSEP pots were obtained and are undergoing testing. (auth)

32035 (CEA-N-1419) SEMIANNUAL REPORT OF THE CHEMISTRY DEPARTMENT, NO. 9, DECEMBER 1969–MAY 1970. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Feb 1971. 474p. (In French). Dep. NTIS (U. S. Sales Only).

Twelve sections are included; ten have been abstracted and indexed for NSA. The remaining studies deal with the electrochemistry of fused salts, the elimination of chemical and biological pollution in liquid waste, desalting of brackish water and seawater, corrosion in seawater desalting, and recovery of enriched boron. (J.G.B.)

For abstracts of individual sections see: 31788, 32036–32042, 32644, and 32773.

32036 (CEA-N-1419, pp 91-113) TREATMENT OF INTERMEDIATE AND LOW LEVEL WASTES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

The ion exchange pilot plant to be located at La Hague has been built and its chemical and hydraulic functioning checked. It can decontaminate ^{90}Sr from more than 450 m^3 of solution with an ion exchange volume of 1.3 m^3. Ruthenium decontamination factors of 25 to 80 on actual effluents were obtained by combining the use of sodium hydrosulfite and activated iron. The use of inorganic ion exchangers of the zeolite type proved highly economical for the cesium decontamination of swimming-pool unloading water. The elimination of radioactive cobalt by coprecipitation of cobalt sulfate reduces the residual cobalt-60 and -58 activity to the level of 1 to 3×10^{-5} Ci/m^3. The ruthenium-103 and -106 decontamination in chemical decladding effluent containing magnesium is strongly influenced by the nitrate ion concentration when this exceeds 100 g/l. The use of bitumen emulsions to embed evaporator concentrates gives good results. The products cast easily at 140°C and stand up well to lixiviation. The thin-layer evaporator used is now operating at outputs of 15 to 25 kg/hr embedded effluent containing 35 to 45% of salts. (J.G.B.)

32037 (CEA-N-1419, pp 235-56) STUDY OF AQUEOUS REPROCESSING METHODS: LABORATORY. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

Studies were continued on improving the efficiency of the plutonium purification cycle and the first-cycle processing of various targets or fuels using tridodecylamine (TDA). The search for a satisfactory aromatic diluant was continued. With alkylbenzenes (densities around 0.87 and flash point 50°C), loads of 16 g/l in 20% solvent by volume can be obtained. The resistance of these diluents to γ radiolysis seems good, and analyses by gas-liquid chromatography show the absence of light degradation products. The stability of TDA nitrate towards α emitters of high specific activity (plutonium-238) was evaluated. About 800 pins of mixed oxide from the core of RAPSODIE were reprocessed. The uranium yields and decontamination factors were satisfactory. The nondissolution of certain fission products in nitric acid and the degradation of the solvent pose a problem at the first extraction cycle stage. (auth)

32038 (CEA-N-1419, pp 257-69) STUDY OF AQUEOUS REPROCESSING METHODS: PILOT PLANT. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

A method for ^{90}Sr extraction from fission product solutions from processing plants was tested in pulsed columns and with inactive solutions. This process includes two extraction cycles for the extraction of rare earths at pH 2 and the extraction of Sr and Mg at pH 4. The extraction cycle at pH 2 raises no particular problems. That at pH 4 will require further study. A nep-

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tunium and plutonium extraction run was carried out on processing solutions. The three extraction cycles include a fission product decontamination cycle with co-extraction of Np and Pu, a reduction cycle for Np extraction with plutonium decontamination by sulfuric acid washing, and a cycle for the recovery of plutonium from the raffinate of the previous cycle. Six hundred grams of neptunium were purified and delivered to SECR in the form of wet oxalate. (auth)

32039 (CEA-N-1419, pp 271-96) STUDY OF DRY PROCESS METHODS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

In regard to research on the processing of enriched uranium alloys by halide volatilization, the sixth test carried out in ATTILA on 3.5 kg of U–Al alloy showed that fluorination must not be undertaken until chlorination of the alloy is complete. In this test almost all the zirconium-95 and niobium-95 were found in the oxides obtained by pyrohydrolysis of the chlorides, while practically all the ruthenium, cerium, and cesium remained in the alumina beds. A sodium fluoride column, divided into 16 stages was used, and fission product distribution profiles along it were obtained. Niobium, zirconium, and ruthenium are fixed at the head, whereas cerium and cesium, probably carried mechanically, are distributed less regularly. A large fraction of the cesium can be extracted from the alumina beds by dissolution in the form of fluoride. Simultaneously with mechanical decladding tests at 500°C in the presence of oxygen, research on the processing of mixed oxides UO_2-PuO_2 by halide volatilization was pursued in the CLOVIS facility. Tests on loads of 1 or 2 RAPSODIE-type pins showed that the use of carbon dioxide at 350°C for the separation of uranium and plutonium hexafluorides gives better results than the use of sulfur dioxide or thermal decomposition of PuF_6 at 350°C. The solid obtained from the reduction of plutonium hexafluoride by carbon dioxide has a plutonium content very close to that of the tetrafluoride and contains little uranium (0.14%). The uranium hexafluoride formed contains very little plutonium (300 mg Pu/kg U). Only 80% of the plutonium is obtained directly in the form of tetrafluoride, although 12 to 17% of the plutonium involved can be recovered by refluorination of the apparatus. Two fluorination tests on pin sections without separation of the cladding were performed in a rotating furnace. For one test the separation of uranium and plutonium hexafluorides was carried out by passage over a sodium fluoride column heated to 400°C. (auth)

32040 (CEA-N-1419, pp 297-330) PREPARATION AND STUDY OF ACTINIDE ELEMENTS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

The behavior of neptunium in nitrous acid solution and in the presence of TBP was studied in counter current at two different temperatures, 50 and 35°C, and for two HNO_2 concentrations. These tests revealed the acceleration of the oxidation reaction $Np(V) \rightarrow Np(VI)$ by either temperature or HNO_2. The recovery of neptunium and plutonium in the first cycle of the processing of a U–Al fuel was studied. The aim was to co-extract these two actinides with the enriched uranium in a first extractor operating with 15% TBP by volume. Adjustment to the respective valencies U(VI), Np(IV), and Pu(IV) is achieved by hot reduction in the presence of hydrazine followed by a partial reoxidation. The separation stage chosen enables Np and Pu to be re-extracted in the aqueous phase, using a sulfonitric complexing medium. This solution is then treated for Np–Pu separation by the normal method, the tridodecylamine (TDA) extraction. The recovery of americium and curium from fission product solutions was investigated in the case of an aluminous solution from the processing of Pu–Al fuel. The recovery of Am and Cm exceeds 99%. The dismutation of neptunium(V) was studied under the actual processing conditions of the TDA–HNO_3 extraction. The effects of acidity were studied and an approximate value of the constant is given. Certain conditions for the U(VI)–Pu(IV) separation by extraction of the former in various solvents (TBP, TDA–HNO_3) were determined. This separation can be used for ^{236}Pu measurement in ^{238}Pu. (auth)

32041 (CEA-N-1419, pp 331-409) STUDY OF THE VITRIFICATION OF FISSION PRODUCT SOLUTIONS. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

The effects of the addition of fluorinated compounds to fission product solutions were studied, particularly so far as volatility and the behavior of the glass are concerned. The possibility of recovering certain fission products by direct lixiviation of the calcinate produced in the continuous vitrification plant was also studied. Tests were made on the vitrification in pots of fission product solutions containing molybdenum, the aim being to abolish chemical reactions between the additive suspension and the solution during feed-in. The plant dealing with vitrification in pots was used as a technical support for the pilot PIVER in testing the vitrification of solutions containing aluminum ions. In order to reduce the volatility of ruthenium-106, a technique to vitrify evaporation concentrates in neutral solution was developed. This technique, tested in the pilot PIVER, reduced the volatility of this isotope to less than 1%. (auth)

32042 (CEA-N-1419, pp 411-40) FUNDAMENTAL STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

The action of capric acid on the extraction of elements with valencies 4^+ by tridodecylammonium nitrate is interpreted as an association of the ammonium salt and the dimerized acid in the organic phase, corresponding to a negative synergism. The curves of the Pu(IV) separation coefficients as a function of the organic acid and nitric acid concentration are discussed. The equilibrium constant of Np(V)–Np(VI) oxidation by the NO_3^- ion in the presence of HNO_2 as catalyst was determined experimentally (measurement of the apparent distribution coefficient of Np in 30% TBP). This constant is a regular function of temperature and nitric acidity. The thermodynamic constants ΔH, $\Delta S°$, and $\Delta G°$ are given at 35°C as a function of the nitric acid concentration. Competition between HNO_3 and HNO_2 during the extraction of $Pu(NO_3)_4$ and $UO_2(NO_3)_2$ by tributyl phosphate in nitric solution was studied. Alkaline solutions of U(VI) were found to give a polarographic reducing wave corresponding to $U(VI) \rightarrow U(V)$, reversible in 1N NaOH ($E° = 0.89$ V). Various oxidation–reduction reactions of heptavalent Np and Pu ions were investigated. (J.G.B.)

32043 (NP-18827) SOLVENT EXTRACTION OF 4f- AND 5f-SERIES ELEMENTS IN FUSED-SALT MEDIUM. Foos, Jacques (Paris Univ., Orsay (France). [Faculte des Sciences]). [1970]. 29p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The extraction of elements of the 4f series (Sm, Eu, Gd, Tb, and Dy) and the 5f series (Am, Cm, Bk, and Cf) from ionized fused salts ($LiNO_3-KNO_3$ eutectic with the ratio 1/2 in weight) was made using TBP or TPPO in solution with a mixture of polyphenyls. The extraction of Tb and Bk is almost impossible using solvating agents from this oxidizing medium: this is due to the formation of TbO_2 and BkO_2, which are not extractable (Tb^{IV} and Bk^{IV} f^7). The results obtained for the other M^{3+} elements solvated in the fused salt demonstrate the specific behavior of each element: Sm, Dy, and Cf are extracted as $M(NO_3)_3 \cdot 3TBP$ and $M(NO_3)_3 \cdot 2TPPO$; Am and Cm as $M(NO_3)_3 \cdot 2TBP$ and $M(NO_3)_3 \cdot 2TPPO$. Europium appears in the organic phase as $Eu(NO_3)_3 \cdot 1,5TBP$ and $Eu(NO_3)_3 \cdot TPPO$ and Gd as $Gd(NO_3)_3 \cdot 2TBP$ and $Gd(NO_3)_3 \cdot 1,5TPPO$. TPPO, which is more basic than the TBP, is more specific for each member of the series, although it does not permit an effective separation of 4f elements from the 5f elements in one extraction. (France)

32044 (RT/CHI-(70)46) SCALE REPRESENTATION OF BANKS OF LIQUID–LIQUID EXTRACTION PROCESSES. Abita, M.; Moccia, A.; Pizzichini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Nov 1970. 27p. (In Italian). Dep. NTIS (U. S. Sales Only).

In liquid–liquid extraction runs on bank mixer-settlers, troubles often arise in simulating actual process conditions, even in the case of satisfactory contactor efficiency. Laboratory practice in removing such troubles, concerning single phase residence times, type of impeller, type of emulsion in the mixer, entrainments, inlet flowrate constancy measurement, and outlet flowrate pulsation, is related. (auth)

32045 (RT/CHI-(71)3) EVALUATION OF PROBLEMS RELATIVE TO A FLOWSHEET FOR THE REPROCESSING OF FUTURE POWER REACTOR FUEL. Abita, M.; Barocas, A.; Beone, G.; Moccia, A. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 13 Jan 1971. 35p. (In Italian). Dep. NTIS (U. S. Sales Only).

The lay-out of a flowsheet for reprocessing spent fuels from Italian power reactors beginning in 1980 is considered. The research and development topics to be investigated are identified. (auth)

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32046 SOLVENT EXTRACTION OF SOME DIPROTIC NITRO-AROMATIC ACIDS AND OF THEIR COMPLEXES WITH SOME ACTINIDES. I. DISSOCIATION CONSTANTS AND SOLVENT EXTRACTION OF 3-NITRO-p-CRESOL-5-SULPHONIC ACID WITH TRIBUTYLPHOSPHATE. Beran, M. (Nuclear Research Inst., Rez, Czech.). J. Inorg. Nucl. Chem.; 33: 839-43(Mar 1971).

The second dissociation constant, $K_2^H = a_{H}[A^{2-}]/[HA^-]$, for 3-nitro-p-cresol-5-sulphonic acid [H_2A] in 1.0M (H,Na)Cl at 25°C was determined by potentiometric titration and uv visible spectrophotometry as $(2.71 \pm 0.07) \cdot 10^{-7}$ and $(2.72 \pm 0.16) \cdot 10^{-7}$, respectively. The solvent extraction of H_2A from 1M (H,Na)Cl with TBP in n-dodecane at 25°C was also studied. The extractable species appears to be $H_2A \cdot 3TBP$, its apparent formation constant $\overline{K}_{H_2A_3 \cdot 3TBP} = [\overline{H_2A \cdot 3TBP}]/a_H[HA^-][TBP]^3$, is 2.27 ± 0.06. The value of the first dissociation constant $K_1^H = a_H[HA^-]/[H_2A]$, was calculated from the extraction data as 2.06 ± 0.23. (auth) (UK)

32047 THIN-LAYER CHROMATOGRAPHIC SEPARATION OF TRIFLUOROACETYLACETONE RARE EARTH CHELATES. Tanikawa, Keiichi (Nippon Steel Corp., Kawasaki, Japan); Arakawa, Kiichi. Jap. Anal.; 20: 274-7(Mar 1971). (In Japanese).

Thin-layer chromatographic separation of $Ce(tfa)_4$, $Ce(tfa)_3$, $La(tfa)_3$, $Pr(tfa)_3$, $Sm(tfa)_3$, $Dy(tfa)_3$, $Ho(tfa)_3$, and $Er(tfa)_3$ was carried out by using Eastman chromatogram cellulose sheet. The separation of $Ce(tfa)_4$ and $Ce(tfa)_3$ was possible by a single developer as benzene, toluene, cyclohexane and petroleum benzene. By using mixed solvents, the separation of $Ce(tfa)_4$ > $Er(tfa)_3$ > $Dy(tfa)_3$ was done with petroleum benzene–acetylacetone (40 : 1) and the separation of Al(III) or Cr(III) and Cu(II) as well as that of rare earths was done with cyclohexane–acetylacetone (20 : 1). The R_f values were in the order, $Al(tfa)_3$ > $Ho(tfa)_3$ > $Cu(tfa)_2$. The separation of $La(tfa)_3$ > $Sm(tfa)_3$ > $Nd(tfa)_3$ was done by development with toluene–cyclohexane–acetic acid (30 : 20 : 1). (auth)

32048 CONTINUOUS SEPARATION OF PLUTONIUM AND AMERICIUM BY COUNTERCURRENT EXCHANGE. Bilal, B. A.; Metscher, K. (Hahn-Meitner Inst. fuer Kernforschung, Berlin). Atomwirt., Atomtech.; 16: 131(Mar 1971). (In German).

Through an electric cell, a solution of 2 N acetic acid and 0.05 N nitric acid flows continuously from cathode to anode. The cell is divided into two components by an asbestos filter, permitting transportation of ions but not of liquid. When plutonium–americium mixtures are treated in the cell, the americium travels toward the cathode, while the plutonium forms an acetate complex that travels toward the anode. The separated elements can be withdrawn continuously. The separation procedure is especially suitable for separation of ^{241}Am formed through β decay of ^{241}Pu. (H.B.G.)

32049 COLLECTION OF URANIUM IN SEA-WATER. VI. ADSORPTION OF URANIUM IN SEA-WATER WITH TITANIC ACID. Ogata, Noboru Nippon Genshiryoku Gakkaishi; 13: 121-7(Mar 1971). (In Japanese).

The adsorbing capacity for uranium shown by titanic acid prepared in homogeneous and acidic solution was found larger than titanic acid prepared in nonhomogeneous and neutral solution. The uranium adsorbed on titanic acid increased with rising temperature of seawater. The adsorption reached equilibrium within 2 days. The concentration of uranium in the titanic acid was found experimentally to have a maximum value of U/Ti = 1,500 μg/g. The concentration of uranium adsorbed on the titanic acid at a given temperature was determined by the amount of seawater and the concentration of uranium in seawater on the same titanic acid. An empirical formula was obtained for this relationship; the adsorption was applied to Freundlich's isotherm, and the distribution coefficients were found nearly constant within the range of seawater volume covered by the present experiment. The adsorption capacity was estimated from the term of multiplication of the distribution coefficient and the concentration of uranium in seawater. The maximum value evaluated was U/Ti = 4,200 μg/g, with the titanic acid prepared by hydrolysis. The uranium adsorbed on the titanic acid increased with rising temperature of the seawater, the empirical relationship being $c = k \exp(\alpha t^2)$, (c: concn. of U, t: temp., k and α: const.). (auth)

32050 EXTRACTION OF ZIRCONIUM(IV) FROM HYDROCHLORIC ACID SOLUTIONS BY HIGH-MOLECULAR-WEIGHT AMINES. Sato, Taichi; Watanabe, Hiroshi (Shizuoka Univ., Hamahatsu, Japan). Anal. Chim. Acta; 54: 439-46(May 1971).

The extraction of zirconium(IV) from hydrochloric acid solutions with various amines in benzene was investigated under different conditions, in order to examine the effect of amine structure on the extraction. Tertiary amines are more efficient extractants for zirconium than secondary amines; the efficiency increases with the chain length of alkyl group and is enhanced when the alkyl chain in the tertiary amine is branched; a benzyl group is essential for promoting extraction efficiency. Organic solutions from the extraction were examined by infrared and high-resolution nmr spectroscopy, and thermal analyses (TGA and DTA) were carried out for the complex prepared by drying the organic phase. (auth)

32051 EFFECT OF CONSECUTIVE COMPLEX FORMATION ON THE SEPARATION OF RARE EARTHS BY ELECTROMIGRATION. Ohyoshi, Emiko (Kumamoto Univ., Japan). Bull. Chem. Soc. Jap.; 44: 423-6(Feb 1971).

The effect of a complexing agent with which rare earths consecutively form complexes on the separation of an adjacent pair of rare earths by electromigration was investigated. By assuming the complexes ML and ML_2 to be formed, the relation of the separation factor, the difference in the zone mobility of the two rare earths, to the ligand-ion concentration was derived and examined for the separation of the La–Ce and Ce–Pr pairs by using nitrilotriacetic acid (NTA), which is known to form the ML and ML_2 complexes with rare earths. It is found that the separation is affected not only by the difference in the first (k_1) or the second (k_2) consecutive formation constant of the two elements to be separated, but also by the value of the k_1/k_2 ratio. (auth)

32052 SEPARATION OF COPPER ISOTOPES BY ION-EXCHANGE CHROMATOGRAPHY. Kanzaki, Tadao; Kakihana, Hidetake (Tokyo Inst. of Tech.). Bull. Chem. Soc. Jap.; 44: 305-10(Feb 1971).

A breakthrough experiment on the separation of copper isotopes was carried out through the use of a cation exchange resin column. By analyzing the experimental results, the approximate values of the single stage (elementary) separation factors, S_{65}^{63}, were determined. The copper sulfate and copper chloride systems gave significant separation factors ($S_{65}^{63} = 1.0000_3 - 1.0004_2$), but the copper nitrate system gave no isotope separation. These data were analyzed in terms of the theory of the two-phase distribution of isotopes previously proposed by one of the present authors (Kakihana). The equilibrium coefficient for isotopic exchange reactions by complex formation in an external solution ($K_1 = 1.0001_5$ for the copper sulfate system, and $K_1 = 1.0005$ for the copper chloride systems) was estimated. (auth)

32053 SEPARATION OF RADIORUTHENIUM AND OTHER FISSION PRODUCTS ON THE REDOX ION EXCHANGER ZIRCONIUM OXIDE HYDRATE–DITHIONITE. Winkler, Raimund (Gesellschaft fuer Strahlenforschung mbH, Neuherberg, Ger.); Sansoni, Bruno, Starke, Kurt. Radiochim. Acta; 15: 65-70 (Mar 1971).

From solutions of uranium fission products, 99 to 99.9% of $^{103}Ru/^{103m}Rh$ or $^{106}Ru/^{106}Rh$ were deposited on a BioRad-HZO-1-dithionite column by reduction to an insoluble form, probably the metallic state. Initially retained by ion exchange, most of the other nuclides (isotopes of iodine, and of alkali, alkaline earth, and rare earth elements) were separated in groups of elution. With alkaline hypochlorite solution, 65 to 80% of the deposited ruthenium/rhodium could be oxidized and also eluted. The samples were found to be radiochemically pure. Besides the residual ruthenium and a maximum of 2% of the rare earths, ^{95}Zr and ^{95}Nb remained on the column. (auth)

32054 EXTRACTION OF ZIRCONIUM(IV) FROM SULPHURIC ACID SOLUTIONS BY DI-(2-ETHYLHEXYL)-PHOSPHORIC ACID. Sato, Taichi; Nakamura, Takato (Shizuoka Univ., Hamamatsu, Japan). J. Inorg. Nucl. Chem.; 33: 1081-7(Apr 1971).

The partition of zirconium(IV) between sulphuric acid solutions and solutions of bis(2-ethylhexyl) phosphate in an organic solvent was investigated. Ir and high-resolution nuclear magnetic resonance spectra were obtained for the organic phase, and the apparent molecular weight of the compound prepared by drying the zirconium-saturated organic phase was determined in benzene. The mechanism of the extraction is discussed on the basis of these results. (auth) (UK)

32055 KINETICS AND MECHANISM OF THE DISSOLUTION OF THORIUM OXIDE IN HYDROFLUORIC ACID AND NITRIC ACID MIXTURES. Takeuchi, Takeji (National Research Inst. for Metals, Tokyo). J. Inorg. Nucl. Chem.; 33: 1089-98(Apr 1971).

Sintered ThO_2 pellets were dissolved in HF–HNO_3 solutions of various compositions and temperatures. The rate of dissolution was observed to be proportional to the fraction of surface sites covered by HF and to the fraction of reactive surface sites covered by undissociated HNO_3. Evidence is presented which indicates that

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ThO_2 surface sites react with HF to form a surface fluoride which in turn adsorbs molecular HNO_3. The rate was expressed as a function of total HF concentration, undissociated HNO_3 concentration, and temperature. The heat of activation was found to be 10.5 kcal per mole. A rate determining step is proposed which involves the reaction between an adsorbed HNO_3 molecule and the surface fluoride of ThO_2. (auth) (UK)

32056 NEW EXTRACTION AGENTS FOR CESIUM. III. COMPLEX FORMED BETWEEN SOME CESIUM SALTS AND 2,3,11,12-DIBENZO-1,4,7,10,13,16-HEXAOXOCYCLO-OCTADECA-2,11-DIENE(DIBENZO-18-CROWN-6). Rais, J.; Selucky, P. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 6: 257-64(24 Apr 1971).

The extraction of cesium into nonpolar solvents, e.g., chloroform, in the presence of dibenzo-18-crown-6 and dipicrylaminate (or tetraphenyl borate) anion is described. The influence of some other univalent cations was studied and practical separation factors for some radioelements are given. (auth)

32057 CONTROL OF ENRICHMENT OF URANIUM IN ^{235}U BY MEANS OF TRACKS PRODUCED BY ALPHA PARTICLES IN CELLULOSE NITRATE. Chapuis, A.-M. (CEN, Fontenay-aux-Roses, France); Francois, H.; Nicodeme-Gerard, N. Radioprotection; 4: 203-14(1969). (In French).

Cellulose nitrate registers the passage of α particles, and is insensitive to light, β particles, and electromagnetic radiations. These properties make it suitable for the control of the ^{235}U enrichment in metallic U samples. In order to facilitate the measurement and to make visible the α tracks for enumeration by optical microscopy, the samples are developed in a special bath and the number of tracks per surface unit is evaluated as a function of the changes of the reflective power of the sample. The principles of the method, characteristics of the ionographic detector, determination of the specific activity of a thick source, the reading procedure, and the evaluation of the enrichment rate are described. (J.S.R.)

32058 ISOLATION OF RADIORUTHENIUM FROM FISSION PRODUCT MIXTURES BY DISTILLATION. Krtil, J. (Inst. of Nuclear Research, Rez, Czech.); Mencl, J.; Bulovic, V. Radiochem. Radioanal. Lett.; 6: 219-26(24 Apr 1971).

A distillation method for isolation of radioruthenium as RuO_4, after oxidation of Ru salts with $K_2S_2O_8$, is described. The factors that influence the oxidation and distillation of Ru were studied in detail, and the method was used for the isolation of $^{103}Ru(^{106}Ru)$ from irradiated uranium samples. (auth)

32059 NEW EXTRACTION AGENTS FOR CESIUM. II. COMPLEXES OF 3,5-di-t-BUTYLCATECHOL AND 4-t-BUTYLCATECHOL WITH ARSENIC(V). Selucky, P.; Rais, J. (Nuclear Research Inst., Rez, Czech.). Radiochem. Radioanal. Lett.; 6: 211-17(24 Apr 1971).

The extraction of ^{137}Cs into nitrobenzene with two complex acids of arsenic(V) containing substituted catechols is described. Some separation factors from other radioelements are given and the mechanism of extraction is qualitatively discussed. (auth)

32060 RECOVERY OF URANIUM OXIDE SCRAP. (to Westinghouse Electric Corp.). British Patent 1,228,525. 15 Apr 1971. Priority date 4 Apr 1968, United States.

A method is described for recovery of uranium in one step from uranium oxide scrap originating from the production lines for fuel pellets and containing impurities such as Si, B, and C derived from the grinding wheel and/or the grinding lubricant. The U scrap and the impurities are reacted with elemental fluorine at a temperature ranging from 300 to 500°C to form a product containing UF_6 and the volatile fluorides of the impurities. All solids are removed from the gaseous products, and the gaseous products are then cooled to a temperature below the boiling point of UF_6 and above the boiling point of the volatile fluorides of the impurities so that only the UF_6 condenses and is recovered free from impurities. (B.L.M.)

32061 RADIOACTIVE ENRICHING BY ZONE MELTING. Cressely, J.; Adloff, J. P.; Deluzarche, A.; Maire, J. C.; Tanielian, C. (Laboratoire de Chimie Organique Appliquee, Strasbourg. Laboratoire de Chimie Nucleaire, Strasbourg). Int. J. Appl. Radiat. Isotop.; 22: 67-71 (Feb 1971).

Zone melting was applied to hexahydrated uranyl nitrate for the separation of radioactive descendents of uranium. An important increase of γ activity was observed and study of the γ spectrum revealed that this variation is due to a displacement of the first descendent of ^{238}U: ^{234}Th. This separation technique may be used with profit in radiochemistry. (auth) (UK)

32062 A STUDY OF THE EXCHANGE EQUILIBRIA BETWEEN METHYLACETYLENE-d AND WATER BY MASS SPECTROMETRY AND A STUDY OF THE SEPARATION OF THE ISOTOPIC ISOMERS OF NO BY LOW TEMPERATURE GAS CHROMATOGRAPHY. Smith, Jessie Gregory. New York; Columbia Univ. (1970). 193p. University Microfilms Order No. 71-6259.

Thesis.

The single stage enrichment factor, α, was measured for the base-catalyzed exchange of deuterium between methylacetylene and water as a function of temperature. Values of α were determined from mass spectrometric analyses of the deuterium content in equilibrated methylacetylene and from the known initial compositions of the reactions. Procedures developed for the analysis of the deuterated methylacetylene are discussed in terms of the use of this reaction for analysis of the deuterium content of water. Some results are presented for analyses of water containing between 1 and 80 atom percent deuterium. The range of sample sizes and concentrations for which this procedure is applicable are given. A study was made of the possible use of gas chromatography for separating and analyzing the isotopic isomers of nitric oxide. Silica gel, glass beads, molecular sieve 5A and porous glass were investigated in adsorption columns, while Chromosorb W with 2-methylpentane and porous glass with a silicone oil were studied in partition columns. The most favorable results were obtained for Chromosorb W with 2-methylpentane in an 18-foot column. The results for the various columns are discussed in terms of the possible formation of nitric oxide dimers in the liquid phase as opposed to adsorbed monomers. (Diss. Abstr. Int., B)

32063 ABSORPTION AND FIXATION OF RADIATIONS EMITTED BY RADIOACTIVE WASTE. Brunet-Debaisnes, Guy. French Patent 1,587,017. 26 Jan 1970. Filed 17 Oct 1968. (In French).

A procedure for the absorption and fixation of radioactive waste and particles using alumino-magnesium silicates is described. It may be in the form of a soap for cleaning the skin and wounds, an emulsion for decontaminating clothes, or in the form of a screen for protection against a contaminated atmosphere. (auth)(France)

32064 SOLVENT EXTRACTION STUDIES OF THE LANTHANIDES WITH TWO STERICALLY HINDERED β-DIKETONES. Brengartner, Dennis Alvin. Columbus, Ohio; Ohio State Univ. (1970). 152p. University Microfilms Order No. 71-7405.

Thesis.

Solutions of 0.10 M 1,1,1,2,2,3,3-heptafluoro-7,7-dimethyl-4,6-octanedione, H(fod), and 0.10 M 2,2,6,6-tetramethyl-3,5-heptanedione, DPM, in carbon tetrachloride were used to study the extraction of praseodymium, samarium, europium, gadolinium, and terbium by a back extraction technique. The pKa of the former reagent and the distribution of both reagents between the organic phase and the aqueous phase, 0.10 M tetraethylammonium perchlorate, were obtained. The lanthanides studied were essentially 100% extracted at pH values between 5.5 and 8.5 in the 0.10 M H(fod) system. The 0.10 M DPM system extracted the lanthanides at values about 3 pH units higher than the 0.10 M H(fod) system. A solution of 0.10 M H(fod) in benzene was used to investigate the separation of all the tripositive lanthanides except lanthanum, cerium, and promethium. Fe(III) and Cu(II) could be separated from other metals (except In(III) and Yb(III)) in a single extraction. In(III), Ni(II), Tl(I), and Cd(II) were partially extracted in the pH range investigated. Al(III), Cr(III), Ga(III), and Pt(IV) did not extract under the same conditions. All the lanthanide metals investigated were quantitatively extracted from the buffer in less than four minutes in the pH range of 5.7 to 7.0. Although the separation factors were relatively low for adjacent members of the series, separations were shown possible by fractionating three synthetic lanthanide mixtures (Eu–Tb, Pr–Eu–Yb, and Lu–Yb) in a Craig-type countercurrent distribution apparatus. (Diss. Abstr. Int., B)

32065 EXTRACTION OF PERRHENATE AND PERTECHNETATE WITH N-BENZOYL-N-PHENYLHYDROXYLAMINE. Fouche, K. F. (Univ. of Orange Free State, Bloemfontein, S. Africa). J. Inorg. Nucl. Chem.; 33: 857-61(Mar 1971).

A study of the extraction of perrhenate and pertechnetate by N-benzoyl-N-phenylhydroxylamine (HBPHA) from concentrated perchloric and hydrochloric acids showed that both ions are extracted as solvated acids of the type $HMO_4 \cdot HBPHA$. (auth)(UK)

32066 HOMOGENEOUS PRECIPITATION AND A THERMOGRAVIMETRIC STUDY OF SOME CERIUM, PRASEODYMIUM, AND NEODYMIUM DICARBOXYLATES. Wynne, Alfred Martin. Amherst, Mass.; Univ. of Massachusetts (1970). 142p. University Microfilms Order No. 71-5960.

Thesis.

Several lanthanide dicarboxylate precipitates were formed homogeneously by the hydrolysis of urea. Quantitative recovery

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was obtained only with oxalic acid and sebacic acid. Precipitation of cerium, praseodymium, and neodymium, as succinates, adipates, and suberates was incomplete. With the exception of the sebacates, normal salts were obtained when precipitation was terminated at low values of pH. At higher values of pH, basic compounds were formed, an observation especially pronounced for cerium. Only basic sebacates were observed at all values of pH. Thermal decomposition in air produced what appeared to be a one step conversion of the cerium compounds to CeO_2. Praseodymium and neodymium dicarboxylates decomposed in a stepwise fashion. Two decomposition patterns were observed. For praseodymium and neodymium sabacate and for praseodymium and neodymium adipate precipitated at values of pH greater than 5, the following decomposition pattern was suggested:

$$Ln_2(An)_3 \rightarrow Ln_2O(An)_2 \rightarrow Ln_2O_{1.5}(An)_{1.5} \rightarrow Ln_2O_2(An) \rightarrow Ln_2O_2CO_3 \rightarrow \begin{matrix} Pr_6O_{11} \\ Nd_2O_3 \end{matrix} \leftarrow Ln_2O_{2.5}(CO_3)_{0.5} \leftarrow$$

as opposed to that for praseodymium and neodymium adipate precipitated at values of pH less than 5:

$$Ln_2(An)_3 \rightarrow Ln_2O_{0.5}(An)_{2.5} \rightarrow Ln_2O_{0.5}(CO_3)_{0.5}(An)_2 \rightarrow Ln_2O_2CO_3 \leftarrow Ln_2O_{0.5}(CO_3)_{2.5} \leftarrow Ln_2O_{0.5}(CO_3)(An)_{1.5} \leftarrow$$

$$\rightarrow \begin{matrix} Pr_6O_{11} \\ Nd_2O_3 \end{matrix}$$

No separation of praseodymium from neodymium was obtained by fractional precipitation as adipates and sebacates. (Diss. Abstr. Int., B)

32067 SAFETY IN THE CHEMICAL LABORATORY. LXXIV. CONTROL OF LABORATORY AND PILOT PLANT WASTE WATER EFFLUENTS. **Young, Irving G.; Blakeley, Christopher P.** (Honeywell Inc., Fort Washington, Pa.). J. Chem. Educ.; 48: A255-6; A258; A260; A262-4; A267(Apr 1971).

Laboratory wastes can vary considerably from domestic sewage and manufacturing plant waste waters. Quantitative and qualitative analyses will permit segregation of wastes into three major categories: those that meet applicable pollution limits and can be discharged without treatment; those that are compatible with municipal sewage or industrial waste treatment practices taking into consideration the effect of dilution in the collection system; and those that must be treated prior to discharge. Thus, only the smallest volumes are admitted for treatment, reducing capital expenditures and treatment costs. A wide variety of treatment methods are available ranging from electrolytic destruction through ion exchange, chemical precipitation, aeration, ozonation, and simple pH adjustment. Automatic analysis and control is available so that most treatment facilities can operate continuously on a virtually unattended basis providing a safe effluent and a permanent record of compliance with legislation at minimum labor cost. (auth)

32068 PREDICTION OF EQUILIBRIUM DATA FOR THE SOLVENT EXTRACTION SYSTEM $SmCl_3$–$NdCl_3$–$CeCl_3$–HCl–H_2O WITH THE EXTRACTANT DI-(2-ETHYLHEXYL) PHOSPHORIC ACID IN AMSCO. Ioannou, Tom Kyriacou. Ames, Iowa; Iowa State Univ. (1970). 127p. University Microfilms Order No. 71-7284. Thesis.

Equilibrium data for the system $CeCl_3$–HCl–H_2O–1 M D2EHPA (in Amsco Odorless Mineral Spirits) were obtained for a wide range of acidities and aqueous lanthanide concentrations. The equilibrium curves for $CeCl_3$ are of the same shape as the other lower lanthanides. A mathematical model was developed to predict the organic concentration as a function of the aqueous phase variables for the above system. Equilibrium data were also obtained for the systems $SmCl_3$–$NdCl_3$–HCl–H_2O–1 M D2EHPA–Amsco and $SmCl_3$–$NdCl_3$–$CeCl_3$–HCl–H_2O–1 M D2EHPA–Amsco. The data for the binary salt system were obtained at total aqueous lanthanide concentrations of ~0.64 M and ~0.11 M over a wide range of acidities and mole fraction of Sm in the aqueous phase. The ternary salt system was studied at a total aqueous metal concentration of ~0.64 M over a wide range of acidities, mole fraction of Ce and mole fraction of Sm on a cerium free basis in the aqueous phase. The total organic concentration for the above systems may be predicted by the sum of a series of linear terms analogous to Raoult's Law for ideal solutions, and terms measuring the interaction effects (deviations from ideality). The interaction effects were correlated empirically as a function of the aqueous phase variables and can be predicted with an average error of less than 4%. The separation factor, $\beta_{Sm,Nd}$, for the binary and ternary systems was essentially constant for all conditions studied. Also, it was found that in the ternary system, the separation factor of each combination pair of elements remains the same as in the case where each pair is extracted together. (Diss. Abstr. Int., B)

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EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 32030, 32090, 32099, 32187, 32264, 32292, 32371, 32373, 32374, and 32395.

32069 (CONF-700840-1) NUCLEAR TECHNIQUES IN GROUNDWATER HYDROLOGY. Calf, G. E.; Campbell, B. L.; Ellis, W. R.; Spragg, W. T. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). [nd]. 8p. Dep. NTIS (U. S. Sales Only).

From Groundwater symposium; Kensington, Australia (9 Aug 1970).

Concentrations of combinations of stable oxygen and hydrogen isotopes in oceanic water are discussed in terms of liquid-vapor phase changes and deviations from the "standard mean ocean water". Other hydrological aspects of isotopes considered are the role of tritium and ^{14}C in age determinations, groundwater studies using natural isotopes, tracer studies utilizing reactor-produced radioisotopes, borehole logging, and the development stage of such techniques in Australia. (Australia)

32070 (HASL-242, pp I.2-23) NATURAL RADIOACTIVITY AND RADIATION. Harley, John H.; Lowder, Wayne M. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

The levels of natural radioactivity in the environment and man have been compiled largely from secondary sources. The values are intended to be useful for generalizations on radiation exposure in the United States. The radioactivity data are presented as a series of tables including concentrations in diet and man and the expected radiation doses. The external radiation dose is covered separately. (auth)

32071 (USGS-474-87) HYDRAULIC TESTING AND SAMPLING OF WATER WELL NUMBER 1, PROJECT WAGON WHEEL, SUBLETTE COUNTY, WYOMING. Voegeli, Paul T. Sr. (Geological Survey, Denver, Colo.). Mar 1971. Contract AT(29-2)-474. 26p. Dep. NTIS.

The Wagon Wheel Water Well No. 1 was drilled to obtain hydraulic data and to provide a water supply for the deep drilling program at the site of Project Wagon Wheel, which is aimed at determining the feasibility of nuclear stimulation of natural gas reservoirs. The well was tested and water samples were collected by swabbing on August 1, 1969, and by pumping on August 26, 1969. In both tests the 2,500-foot section through which the well was drilled was tested through 19 gun-perforated intervals. The water level in the well prior to the pumping test was 98.1 feet below land surface. During the pumping test the water level declined to 156.6 feet below land-surface datum while the well was pumped at an average rate of 51.6 gallons per minute for 6 hours and 6 minutes. The transmissivity of the aquifer in the vicinity of the well, as computed from the data of the pumping test, was 2,100 gallons per day per foot, and the specific capacity was 0.88 gallon per minute per foot of drawdown. (auth)

32072 IMPACT OF THE NATURAL SCIENCES ON ARCHAEOLOGY. Symposium Held in London, December 11-12, 1969. Phil. Trans. Roy. Soc. London, Ser. A; 269: 1-185(17 Dec 1970). (CONF-691207).

Seventeen papers were presented at the Symposium. A separate abstract was prepared for each of 2 papers. (UK)

For abstracts of individual papers see: 32073 and 32074.

32073 CRITICAL ASSESSMENT OF RADIOCARBON DATING. Barker, H. (British Museum, London). Phil. Trans. Roy. Soc. London, Ser. A; 269: 37-45(17 Dec 1970).

From Symposium on the impact of natural sciences on archaeology; London, England (11 Dec 1969). See CONF-691207.

The many and complex factors involved when assessing the accuracy of radiocarbon dates, make it relatively easy to arrive at erroneous conclusions through incautious comparisons of published dates. Correct manipulation of the standard deviation may not be enough, in itself, to prevent wrong conclusions being reached since the published error term cannot take into account all the factors which influence the accuracy of the date. The existence of discrepancies between radiocarbon and calendar dates does not invalidate the method, although these discrepancies do impose some restrictions on the accuracy of the method in certain regions of time. In the main, however, they do no more than make the application of the method more complex and serve to emphasize the need for closer collaboration between the archaeologist and the scientist in the dating laboratory. Secondly, the liquid scintillation technique provides a means of increasing the output of dates at reduced cost compared with the proportional gas counting technique, with no reduction in the standards of accuracy and a considerable increase in one's confidence in the results. One can expect that facilities for dating will improve throughout the world as it comes into more general use. Certainly in this country the facilities for archaeological dating are no longer limited by purely technical considerations. In fact the only obstacle to a further large increase in output lies in the difficulty of obtaining sufficient staff to operate to full capacity the equipment already in use. (auth) (UK)

32074 NEUTRON ACTIVATION ANALYSIS OF ARCHAEOLOGICAL ARTEFACTS. Gordus, A. A. (Univ. of Michigan, Ann Arbor). Phil. Trans. Roy. Soc. London, Ser. A; 269: 165-74(17 Dec 1970).

From Symposium on the impact of natural sciences on archaeology, London, England (11 Dec 1969). See CONF-691207.

The elemental compositions of archaeological artefacts, ancient and medieval coins, and metallic art objects were determined by non-destructive neutron activation analysis. Examples are given of studies of prehistoric trade routes and cultural contacts based on the identification of the geologic origins of obsidian artefacts, of early economic systems based on the determination of debasement patterns in medieval Islamic and Western gold and silver coinage, the region of manufacture as well as authentication of ancient metallic art objects based on trace element analysis. Special procedures devised for performing these analyses are described. (auth) (UK)

32075 MEASUREMENT OF ATMOSPHERE AND SOIL RADIOACTIVITY BY AERO METHODS. USE OF HELICOPTERS FOR RAPID DETECTION OF CONTAMINATION BY GAMMA EMITTERS. Farcasiu, O.; Sahagia, H. Bul. Inst. Politeh. Brasov, Ser. B; 11: 57-70(1969). (In Rumanian).

The use of helicopters for the rapid detection of gamma radiation using a recording GM counter was studied. The measurements were made at different heights up to 620 m in uniform radiation fields created by ^{60}Co and ^{131}I sources. The minimum ^{131}I activity that can be detected from a 20 m height is 0.89 $\mu Ci/m^2$. The maximum permissible level of 0.5 $\mu Ci/m^2$ (corresponding to maximum permissible ^{131}I concentration in milk) can be detected up to 3.5 m. From experimental data an equation was obtained which serves in drawing dose/height curves for different soil contamination levels. (auth)

32076 TRITIUM LOSS FROM WATER EXPOSED TO THE ATMOSPHERE. Horton, J. Henry; Corey, John C.; Wallace, Richard M. (Savannah River Lab., Aiken, S. C.). Environ. Sci. Technol.; 5: 338-43(Apr 1971).

Equations describing the loss of HTO from water into air and the gain of HTO in water when the overlying water vapor contains tritium but the solution does not were developed and verified by laboratory experiments. Results show that under environmental conditions, where the relative humidity is greater than 8%, HTO is lost preferentially over H_2O to the atmosphere because atmospheric moisture is virtually free of HTO. Results from a three year study of the changes in tritium content of a large nonseeping outdoor basin were used to extend the laboratory studies to field situations. Data from this field study were used to calculate tritium loss from open basins. These calculations show, for example, that 90% of the tritium contained in an aqueous stream flowing at 15,000 liters per day will be lost to the atmosphere from a shallow basin with a surface area of 6000 m^2. (auth)

32077 DELENIE YADER URANA V PRIRODE. (Fission of Uranium Nuclei in Nature). Shukolyukov, Yu. A. Moscow; Atomizdat (1970). 272p.

The effects of the fission process of uranium nuclei and of transuranium elements on the isotopic content in earth and cosmic materials were studied. New data are given on the isotopic composition of Ar, Kr, and Xe which are contained in radioactive meteorites, minerals, and natural gases. The principles of utilization of the fission process in geochronometry and paleothermometry are discussed, as well as the potential of this new method for studying radiation defects (fission fragment tracks) and the geochemistry of U, i.e., the deposition and distribution of U in minerals and rocks up to ultrabasic levels, and for studying U migration processes. 315 references. (tr-auth)

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32078 FISSION TRACK DATING OF ARCHAEOLOGICAL MATERIALS FROM JAPAN. Nishinuura, S. (Kyoto Univ.). Nature (London): 230: 242-3(26 Mar 1971).

A brief description is given of the method of fission track dating, and studies are described on slags, on minerals in baked earths, pottery and tiles, and on a glass bowl and the glaze on a bowl. Data are tabulated for the fission track ages of zircons and other materials, and also for the uranium content of some relics. The results agreed with archaeologically estimated ages, but several questions remained unsolved. (UK)

32079 TRACER EXPERIMENTS PERFORMED IN FRANCE AS PART OF THE STUDY OF THERMAL POLLUTION IN STREAMS. Guizerix, J.; Gras, R.; Margrita, R.; (and others) (Centre d' Etudes Nucleaires, Grenoble, France). pp 63-79 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The electricity generating industry is responsible for most (approximately 80%) of the heat discharged into streams; careful siting of conventional and nuclear power stations is therefore essential to the control of thermal pollution. Mathematical models of the thermal behavior of streams were developed for evaluating the heat absorption capacity of the French hydraulic system and optimizing the siting of thermal power stations. These models require a knowledge of certain global parameters for measuring of which the best (and often the only) method involves the use of tracers and which represent the flow conditions over long (30 to 100 km) river stretches; they include the mean velocity over a stretch, the average depth, the mean transit time of water particles and the coefficient of longitudinal turbulent diffusion. The tracer is injected at several points in a section so as to reduce the minimum distance required for good mixing and in quantities proportional to the flowrate through the partial sections corresponding to each injection point. The pulse responses between the injection section and different points of the beginning and end sections of the river stretch under consideration are determined. The method of combining the pulse responses so as to define the input and output functions of the tracer in relation to the river stretch in question is also described. The values sought are then calculated from these functions. (auth)

32080 METHODS AND EQUIPMENT USED IN THE USSR FOR DETERMINING ENVIRONMENTAL RADIOACTIVITY. Artemenkova, L. V. (All-Union Research Inst., Moscow). pp 95-107 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Sources of environmental pollution are briefly enumerated and the problems which must be solved in order to determine the degree of such pollution are classified. The special considerations entering into the taking of samples and the making of measurements are examined. Methods of taking air, water and soil samples are described together with the techniques used in the USSR for measuring radioactivity in the samples, including methods of single and continuous measurement and also of fast measurement. A short list of the equipment used in the USSR for environmental monitoring is given. (auth)

32081 STUDY AND DEMARCATION OF POLLUTION IN NON-SATURATED SOILS. Rancon, D. (Centre d'Etudes Nucleaires, Cadarache, France). pp 551-63 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A method was developed for evaluating the intensity and determining the extent of pollution in non-saturated soils and for following its progress, with a view to preventing the pollution of aquifers in particular. A simple device is described which can be rapidly inserted to a depth of 3 to 4 m in loose soils. A neutron moisture gauge is introduced into borehole tubes in order to measure variations in the moisture content of the ground and thereby give warning of any movement of pollutants associated with water movement. A focalized probe specially designed for the purpose is then inserted into the same tubes and measures movement of the activity front of radioactive tracers or of various radioactive pollutants. The greater the number of access tubes the more accurate is the demarcation of the polluted zone. Numerous experimental releases of radioactive liquids have been carried out to test this device, the liquids being labeled with ^{85}Sr to simulate those elements retained by minerals and with ^{131}I to simulate those hardly retained. It was thus possible to measure the relative velocities of the activity and moisture fronts, determine the boundaries of the polluted zone and evaluate the volume of soil polluted. A study has also been made of the behavior of already polluted soil when it is traversed by non-contaminated seepage waters discharged at the surface, the risks of spreading and the possibility of confinement of the pollutants being assessed. The method is ready for use in the field. (auth)

32082 TRACER METHODS FOR PREDICTING THE PROPAGATION OF POLLUTANTS IN HYDRAULIC SYSTEMS AND LOCATING AN UNKNOWN RELEASE POINT. Guizerix, J.; Emsellem, Y.; Corompt. P.; (and others) (Centre d'Etudes Nucleaires, Grenoble, France). pp 583-602 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Use is made in the methods described of the properties of pulse responses which can describe the large-scale movement of pollutants between different points, determination being effected by means of tracers. The first method enables one to predict, for any point in the hydraulic system, variations in the maximum concentrations of a pollutant following a release upstream. The method is valid for any flowrate. The second method, based on the same general analysis of the problem, indicates the type of information required for locating an unknown point of pollutant release by measuring the pollutant concentrations at a point in the flow. The method is valid for any rate of release. (auth)

Meteorology

Refer also to abstracts 32070, 32075, 32076, 32080, 32096, 32144, 32349, 32371, 32377, 32395, 32398–32400, and 32404.

32083 (HASL-242, pp I.85-90) ^{90}Sr YIELD OF THE SEPTEMBER 1969 CHINESE NUCLEAR TEST. Volchok, Herbert L.; Kleinman, Michael T. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970–March 1, 1971.

The ^{90}Sr yield of the tenth Chinese nuclear explosion was computed by relating the surface air concentrations of ^{89}Sr and ^{95}Zr for the first five months of 1970, in New York City, to the ^{90}Sr fallout for the same period, and extrapolating the results to global deposition and stratospheric inventory. The calculated yields averaged 150 kCi and were in excellent agreement with direct measurements. (auth)

32084 (KFK-1336) CONTRIBUTION OF POOR EXCHANGE WEATHER CONDITIONS TO THE RADIATION BURDEN OF THE ENVIRONMENT OF ATOMIC ENERGY FACILITIES. Koenig, L. A. (Kernforschungszentrum, Karlsruhe (West Germany)). Dec 1970. 14p. (In German). Dep. NTIS (U. S. Sales Only).

A method is described which allows the evaluation of the influence of meteorological conditions, e.g., low wind speed and weak vertical mixing, on radioactivity in the environment of nuclear facilities. The method requires the availability of results derived from dose calculations, the weather conditions, and wind statistics broken down by direction and velocity. The method is applied to the Karlsruhe Nuclear Research Center site and reveals, in this particular case, a negligible influence for weather conditions. (auth)

32085 ATMOSPHERIC ^{99}Tc. Attrep, Moses; Enochs, John A.; Broz, Larry D. (East Texas State Univ., Commerce). Environ. Sci. Technol.; 5: 344-5(Apr 1971).

Technetium-99 was isolated from 13 rain samples collected in 1967. The sizes of these samples were 53.5 to 233 liters. The concentrations of ^{99}Tc vary from 0.14×10^{-2} to 1.7×10^{-2} pCi/liter. (auth)

32086 SIMULTANEOUS USE OF ISOTOPE RATIO TRACER AND SULPHUR HEXAFLUORIDE AS A DUAL-TRACER SYSTEM FOR SULPHUR OXIDES IN THE ATMOSPHERE. Manowitz, B.; Smith, M.; Newman, L.; (and others) (Brookhaven National Lab., Upton, N. Y.). pp 223-39 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Recent field work by Brookhaven National Laboratory has demonstrated the operational feasibility of two non-radioactive

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tracer methods for sulfur that make it possible to follow and identify emissions from individual power plant stacks. In addition it has been found that the two methods augment each other and that, when used in concert, they provide a unique system for studying the chemistry of sulfur oxides in the air. The isotope Ratio Tracer (IRT) method, developed by BNL, uses an isotope-ratio mass spectrometer to measure the ratio of sulfur-32 to sulfur-34 in sulfur samples and depends upon the natural variation in the ratio in sulfurs from different sources to characterize them. The tracer behaves exactly as does the sulfur being traced since it is identical with it. Sulfur hexafluoride (SF_6), developed originally by the National Air Pollution Control Administration as a tracer for sulfur in the atmosphere, has been applied to plume dispersion studies by BNL. The use of gas chromatography permits determination of SF_6 at levels on the order to 10^{-3} to 10^{-4} pp^9 in air. Since it is an inert gas at the temperatures involved, SF_6 can be injected into a power plant flue gas system and used to trace the plume emerging from its stack. Experience with the IRT method has indicated that it is sensitive enough to measure the changes in the ratio of sulfur-32 to sulfur-34 that result from isotopic exchange following chemical reaction with adequate precision to indicate the degree of conversion that has occurred. When used simultaneously, SF_6 tracer defines the geometric behavior of the plume and provides a basis for normalizing the data developed by the IRT method. Details of the analytical methods and field procedures are discussed and data obtained on recent experiments are presented. (auth)

32087 SOME NUCLEAR TECHNIQUES FOR ATMOSPHERIC DILUTION AND DISPERSION STUDIES. Nielsen, J. M.; Wogman, N. A. (Pacific Northwest Labs., Richland, Wash.). pp 257-65 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Nuclear techniques can provide unique means for the study of factors relevant to atmospheric pollution. Some of these factors are local dilution and dispersion of material from the source, transport and further dispersion by large-scale atmospheric processes and removal to land and water surfaces by scavenging, deposition, and other interaction processes. A ^{85}Kr tracer field-grid system can provide quantitative measurement of the transport and diffusion on a real time basis out to distances of at least 1600 m. Detectors on a three-dimensional array relay concentration data to a multiparameter analyzer. Data are continuously recorded in consecutive 0.1 to 1600-second predetermined intervals utilizing a buffer memory and magnetic tape storage system. Larger-scale processes may be studied using radionuclides formed by natural processes in the atmosphere. The interaction of cosmic rays with components of the atmosphere continuously produces radionuclides, more than a dozen of which have been observed with half-lives ranging from minutes to millions of years. Depending upon their physical characteristics, these radionuclides may behave as gases and follow the air motions or they may become attached to atmospheric aerosols and serve as tracers of their behavior. Comparisons between the production rates of ^7Be (53 day) and ^{24}Na (15 hr) and their observed concentrations in air together with the bomb-produced radionuclides provide a basis for characterizing vertical air mass movements and precipitation scavenging processes. Measurements of ^{38}Cl (38 min), ^{39}Cl (55 min), and ^{24}Na (15 hr) in rain provide quantitative information of the rates and mechanisms involved in precipitation scavenging. Sodium-24 and ^7Be deposition can be measured at the surface of the earth to provide information on this depletion mechanism. A technique using the cosmic-ray produced radionuclide ^7Be (53 day) has proved valuable for studying the rates of air-to-sea transport of atmospheric particles and the subsequent mixing of the ocean surface waters. Filtration procedures for sampling ^7Be in the lower layers of the atmosphere and absorption procedures for sampling ^7Be in the near surface layers of the ocean were developed and applied during the Barbados Oceanographic and Meteorological Experiment (BOMEX). (auth)

32088 USE OF ACTIVABLE TRACERS FOR STUDYING THE DIFFUSION OF ATMOSPHERIC POLLUTANTS: INDUSTRIAL APPLICATIONS. Guerin, P.; Hugon, J.; Le Quinio, R.; (and others) (Centre d'Etudes Nucleaires, Cadarache, France). pp 267-82 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The high sensitivities obtainable by combining neutron activation with gamma-spectrometry in the determination of microquantities in a complex matrix suggest that "activable" elements could be used as tracers in atmospheric diffusion experiments. The criteria governing the choice of element are: nuclear properties, natural abundance, price, and suitability as a tracer. Gold and indium are among the most suitable elements. Calculation of the sensitivity thresholds is based on measurement of the background, under the experimental conditions, from the apparatus employed and interference by elements in the matrix, which consists of the filters and natural atmospheric dust. The behavior of gold and indium aerosols is compared with that of aerosols of fluorescein salts (the tracer normally used for on-site studies) in medium-scale field experiments involving simultaneous releases. The single-tracer technique has been employed in studying pollution at a refinery site. Indium was used in place of fluorescein, which had to be discarded because of de-activation by the high-temperature gases released to the atmosphere. The indium, which is produced in aerosol form, is collected on atmospheric dust-sampling filters at known distances from the point of release and determined by the activation technique. The release, sampling and analysis conditions are described. Possible ways of improving the technique are indicated. (auth)

32089 AIR POLLUTION STUDIES BY MEANS OF INACTIVE INDIUM TRACER AND ACTIVATION ANALYSIS. Dahl, J. B.; Steinnes, E.; Thomassen, J. (Institutt for Atomenergi, Kjeller, Norway). pp 283-96 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

An inactive tracer method has been used for the study of the field distribution of gaseous air contaminants emitted from factory stacks, etc. Indium oxide particles with diameters in the region of 0.01 to 0.1 μm are used as tracer gas. The particles are formed by the combustion of an alcoholic solution of indium nitrate in an ordinary oil burner. The tracer gas is mixed with the stack gas to be studied and the fall-out of tracer-gas particles in the surroundings is measured by collecting them in small plastic trays filled with water. The content of indium in the samples is determined by neutron activation analysis. The method is very sensitive and is useful in measuring selectively the spread of gases from an existing stack as well as in simulating the spread of gases from stacks to be built. (auth)

Mineralogy and Exploration

32090 (TT-70-50092) GAMMA SPECTROMETRY OF NATURAL ENVIRONMENTS AND FORMATIONS. Theory of the Method Applications to Geology and Geophysics. Kogan, R. M.; Nazarov, I. M.; Fridman, Sh. D. Translation of Osnovy Gamma-Spektrometrii Prirodnykh Sred. Teoriya Metoda Gamma-Spektrometrii i Geologo-Geofizicheskie Prilozheniya, Atomizdat, Moscow, 1969. 350p. (IPST-Cat.-5778). NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 38303.

32091 PROBLEMS OF FUTURE URANIUM SUPPLY FROM THE POINT OF VIEW OF A CANADIAN PRODUCER. Kostuik, J. Erzmetall; 23: 448-52(1970). (In German).

Western Germany will advance to the first line of nuclear energy producers within the next decade. An appeal is made to the uranium consumers of the Federal Republic to make use of the benefits of the Canadian deposits for investments and partnerships. The cumulative trend of U_3O_8 requirements in the Western hemisphere in the seventies and the resulting necessary actions of the uranium producers and consumers are pointed out. (INIS)

Oceanography

Refer also to abstract 32145.

32092 (HASL-242, pp I,35-78) RADIOCARBON IN THE SEA. Fairhall, A. W.; Buddemeier, R. W.; Yang, I. C.; Young, A. W. (Washington Univ., Seattle).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

Of the world inventory of natural ^{14}C, estimated to be 51 metric tons, over 90% resides in the oceans. Atmospheric testing of nuclear weapons increased this supply by about 3%, producing a dramatic increase in ^{14}C concentrations of atmospheric CO_2 during the mid-1960's. This excess is rapidly being equilibrated with the mixed layer of the sea, some $^2/_3$ of the excess ^{14}C having already been transferred to the oceans. Uptake of bomb ^{14}C by the sea is being investigated by a program of analysis of 60 liter

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samples of sea water collected at various depths at numerous places. CO_2 is stripped from the water on board ship and returned to the laboratory for ^{14}C counting. The results show the presence of bomb ^{14}C in the upper few hundred meters of the sea over most ocean areas. Penetration to depths of 700 m occurs in some areas. There is evidence for bomb ^{14}C to depths of 3600 m in the North Atlantic, the region of formation of North Atlantic Deep Water. (auth)

32093 POSTDEPOSITIONAL MOBILITY OF SOME TRANSITION ELEMENTS, PHOSPHORUS, URANIUM, AND THORIUM IN DEEP SEA SEDIMENTS. Bonatti, Enrico; Fisher, D. E.; Joensuu, Oiva; Rydell, H. S. (Univ. of Miami, Fla.). Geochim. Cosmochim. Acta; 35: 189-201(Feb 1971).

Deep sea hemipelagic sediments from the east Pacific show an oxidized upper zone of variable thickness and a reduced zone below. The geochemistry of a core from this region was studied in detail. The Eh of the upper zone is close to +100 mV, while in the lower zone it reaches about –400 mV. Reducing conditions in the lower section of the core are related to the oxidation of organic matter in the sediment, as indicated by the gradual decrease with depth of the concentration of nitrogen in the upper part of the core. Various elements, such as Mn, Ni, Co, P and La, are enriched in the upper oxidized zone, while Cr, V, U and S are enriched in the lower reduced zone. Postdepositional mobility of the elements in question, mainly by diffusion in the interstitial solutions, can explain their distribution in the core. Redox reactions can account directly for the mobilization of Mn, Ni, Co, Cr, V and U, indirectly for that of P and La. Fe and Cu do not migrate significantly, since they are immobilized as sulfides in the reduced zone. Th appears not to be affected by diagenetical mobility. Some of the consequences of the postdepositional mobility of elements in deep sea sediments are: (1) The average elemental content of deep sea sediment, generally estimated from measurements of samples from the upper part of the sediment column, may be affected by errors; namely, an overestimation in the case of Mn, Ni, Co, P and La; an underestimation in the case of V, Cr and U. (2) Postdepositional redistribution of U may introduce errors in age determinations of sediments by the $^{230}Th/^{232}Th$ and $^{230}Th/^{231}Pa$ methods. (3) Some geographical variations in the composition of Fe–Mn nodules can be explained by postdepositional mobility of Mn, Ni and Co. (auth) (UK)

32094 SURVEY SYSTEM FOR USE IN TRACING RADIONUCLIDE-TAGGED SEDIMENT IN THE MARINE ENVIRONMENT. Case, F. N.; Acree, E. H.; Brashear, H. R. (Oak Ridge National Lab., Tenn.). pp 603-28 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Survey equipment for tracing radionuclide-tagged sediment has been designed and field tested. The system is capable of operating on the dry beach, in the breaker zone and in deep water, making it possible to obtain synoptic information in the three important near-shore zones of the ocean. The detector consists of four sodium-activated cesium iodide crystals and is transported in an open wire mesh-covered ball-like vehicle that is towed behind an amphibious vessel. The sensitivity of the detector for ^{198}Au deposited on the bottom of a water body is 2.3×10^3 counts/sec when the radionuclide concentration is 1 $\mu Ci/ft^2$. Data consisting of radiation counts from the detector, time, tow vessel location and water depth are recorded every 2 sec on punched tape. The detector and associated analyzer provide for energy discrimination to increase the versatility of the survey system. The data-collection system and computer programs developed to provide precise location of the detector vehicle may be used with either on-bottom detectors or water-column detectors. The system is described and data obtained in field tests are displayed in the form of computer-processed contour maps of sediment transport. The detector and associated recording equipment provide a system useful for the surveying of underwater waste-disposal areas, for mapping the distribution of dredging spoils and for obtaining underwater background surveys in areas subject to radioactive process effluent discharge. Field applications are described. (auth)

32095 EXPERIENCE GAINED FROM THE CONTROLLED INTRODUCTION OF LIQUID RADIOACTIVE WASTE TO COASTAL WATERS. Preston, A.; Jefferies, D. F.; Mitchell, N. T. (Fisheries Radiobiological Lab., Lowestoft, Eng.). pp 629-44 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The behavior of specific radionuclides discharged in a continuous, routine and controlled manner from established marine outfalls is described, together with the equilibrium levels found in the environment. The examples include the discharge from the United Kingdom Atomic Energy Authority fuel reprocessing plant at Windscale and from the Bradwell nuclear power station of the Central Electricity Generating Board; these and other examples provide evidence of the behavior of a range of radioactive pollutants, principally the nuclides of metals. The way in which experience from these controlled disposals may be applied to other problems of pollution, including chemical pollution, is examined. Used as a research tool, the monitoring of such discharges can show not only how some categories of pollutant distribute and disperse in the water mass, but also the extent to which environmental interaction occurs through reconcentration into a range of biological and physical materials. (auth)

32096 YADERNAYA GIDROFIZIKA. (Nuclear Hydrophysics). Nelepo, B. A. Moscow; Atomizdat (1970). 224p.

The rules for the transport of radioactive contaminants in seas and oceans were studied. A brief review is given of an experimental investigation of coastal regions near Great Britain into which radioactive waste was discharged. The theory and the methods for calculating the transport of radioactivity are presented. Formulas are given for purifying the atmosphere by precipitation scavenging of fallout from nuclear explosions. Statistical studies of the radioactivity from fallout are discussed and formulas for predicting the radiation levels in oceans are presented. 214 references. (tr-auth)

Seismology

32097 JORUM EARLY AFTERSHOCK MEASUREMENTS. Perret, William R. (Sandia Labs., Albuquerque, N. Mex.). J. Geophys. Res.: 76: 2730-4(10 Apr 1971).

An instrumentation system devised specifically to aid in differentiating the locus of early aftershocks in the vicinity of a large underground nuclear explosion was tested during the Jorum event in September 1969. This system included six stations located on three radii from Jorum surface zero. Records from these stations included 115 aftershocks during the initial three-hour postshot period. Arrival times from the 40 largest events during the first hour indicated that 12 were in the chimney area and 28 were at distances between 100 meters and 6.3 kilometers from the explosion. Six events appear to be directly associated with faults identified prior to the shock, and two groups near surface zero suggest new faults in that vicinity. Four later aftershocks, identified in Seismological Notes (Seismological Society of America) for September and October 1969, were found to be within the chimney area. (auth)

32098 COMPARISON OF P-WAVE SPECTRA OF UNDERGROUND EXPLOSIONS AND EARTHQUAKES. Wyss, Max (Univ. of California, San Diego); Hanks, Thomas C.; Liebermann, Robert C. J. Geophys. Res.: 76: 2716-29(10 Apr 1971).

The P-wave displacement spectra of the underground explosions Milrow and Longshot are compared with those of four shallow earthquakes of similar body-wave magnitude (m_b) in the Aleutian Islands. The spectral data ($0.5 \leq T \leq 33$ sec) were obtained from three vertical instruments at Pasadena, approximately 50° from the epicentral region common to the six events. A Novaya Zemlya explosion of comparable m_b was also analyzed. The peak spectral amplitude for the earthquakes occurs at periods several times larger than for comparable m_b explosions, indicating that the earthquakes have source dimensions several times larger than the explosions. For $T < 1.5$ sec, the spectra for both types of events are comparable; the absolute level and the rates of decay (ω^{-2}) with increasing frequency are the same. The Q-corrected explosion spectra peak sharply in the interval $2 \text{ sec} > T \geq 1$ sec and decrease at least as far as ω for longer periods. The earthquake spectra, however, continue to increase to a long-period level. The greatest differences in spectral amplitudes for the events considered occur at periods longer than 3 sec. The observed differences in the P-wave spectra provide a promising method for discriminating between earthquakes and underground explosions. (auth)

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ENGINEERING

Nuclear Explosions

Refer also to abstracts 32071 32097, 32301, and 32302.

32099 (CEA-R-4096) STORAGE VOLUME CREATED BY A CONTAINED UNDERGROUND NUCLEAR EXPLOSION. Rollin, Francois (Commissariat a l'Energie Atomique, Bruyers-le-Chatel (France). Centre d'Etudes). Mar 1971. 48p. (In French). Dep. NTIS (U. S. Sales Only).

The calculation of the storage volume created by a contained underground nuclear explosion is described in detail for four geological media: Hoggar granite, salt, dolomite, and Nevada granite. Different theoretical results concerning the influence of environment on the volume created are presented. In conclusion, the calculation is applied to the determination of off-shore storage volumes. (auth) (France)

Facilities and Equipment

Refer also to abstracts 32189, 32638, and 32639.

32100 (NYO-3930-10) LIQUID METAL BEARINGS TECHNOLOGY FOR LARGE, HIGH TEMPERATURE SODIUM ROTATING MACHINERY. Progress Report, August 1, 1970-January 31, 1971. (Mechanical Technology Inc., Latham, N. Y.). Contract AT(30-1)-3930. 24p. (MTI-71-TR-11). Dep. NTIS.

Activities are reported in a program to develop data and instrumentation needed for reliable design, optimization, and experimental evaluation of Na-lubricated bearings for high-capacity Na pumps and other auxiliaries of the circulation systems of breeder reactors. Information is included on development of design handbooks on self-acting bearings and externally pressurized bearings, and development of Na test bearing systems. (J.R.D.)

32101 (ORO-673) RADIATION INITIATED EMULSION POLYMERIZATION PILOT PLANT OPERATION AND ECONOMIC FEASIBILITY STUDY. Final Report, June 1, 1967-June 30, 1968. Allen, R. S.; Ransohoff, J. A.; Woodard, D. G. (Neutron Products, Inc., Dickerson, Md.). Oct 1969. Contract AT(40-1)-3680. 158p. Dep. NTIS.

Activities in a program to identify and assay the potential benefits of commercial radiation process for latex production are summarized. Results of analyses are included on conventional plant design, production methods, and costs. Information is included on design of radiation catalysis plants, pilot plant design and operation, and market potentials. (J.R.D.)

32102 (WAPD-TM-890) BUSHL: A COMPUTER PROGRAM FOR THE INELASTIC BUCKLING OF SHELLS OF REVOLUTION UNDER EXTERNAL PRESSURE AND AXIAL COMPRESSION. LWBR Development Program. Thurman, A. L. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Mar 1971. Contract AT-11-1-GEN-14. 114p. Dep. NTIS.

BUSHL is a computer program that can be used to determine the load at which finite length shells of revolution buckle when subjected to hydrostatic pressure, axial compression, or a combination of the two. Meridionally curved, double-layered discrete elements are used to obtain the solution. The program includes the effects of large prebuckling deformations and anisotropic inelastic material behavior. BUSHL was developed primarily for the buckling collapse analysis of Zircaloy-clad oxide fuel rods. (auth)

32103 IMPROVEMENTS TO LIQUID METALS ELECTROMAGNETIC PUMPS. Carbonnel, Henri; Le Frere, Jean (to Groupement Atomique Alsacienne Atlantique SA). French Patent 1,593,007. 25 May 1970. Filed 1 Jul 1968. (In French).

An electromagnetic pump is presented, that is able to pump and control the flow of all liquid metals. It consists of a flow pipe for the molten metal, a preheating system for the pipe (a metal layer on one of the external surfaces of the pipe), and a system intended to set in motion the molten metal, consisting of a magnetic circuit distributed from one side to the other side of the pipe. The flow pipe is made of a refractory and insulating material. Several methods of manufacturing the pipe are given. (France)

32104 PROBLEMS IN THE MANUFACTURE OF LARGE-CAPACITY NUCLEAR TURBINES. Kumeno, Kozo; Kitagawa, Yuji (Hitachi Ltd., Ibaraki, Japan). Seisan Gijutsu; 25: No. 9, 16-23(Sep 1970). (In Japanese).

The development of large-capacity turbines for nuclear power generation is discussed. In 1968, a turbine of 138,600 kW capacity was completed for West Pakistan and is now being installed at the site. The design and production system for 1,000,000 kW turbines has been completed. The following are described: the world situation of nuclear power generation and the turbines manufactured by G.E. in the USA, features of a nuclear turbine. The large size of nuclear turbines resulting from a large amount of turbine exhaust steam, the exployment of moisture separators, and the anti-corrosion measures for wet steam, and problems in the manufacture of nuclear turbines, due to low rpm operation, etc. The problems in compartment, rotor, moving blades, diaphragm, moisture separator, and control devices are discussed. (MORI, K)

32105 AUTOMATIC SHUTTING VALVE. Aubert, Gilles (to Commissariat a l'Energie Atomique). French Patent 1,594,134. 1 Jun 1970. Filed 5 Dec 1968. (In French).

This valve consists of a body fixed to the pipe, a clapper hinged to the end of a lever pivoting about a pin external to the pipe, an elastic device for returning the lever and a control tube. The control tube moves in the internal bore of the valve. The walls do not intersect and sealing problems are thus eliminated. The tube controls the opening of the clapper and guides the movement of the parts or the fluid entering or leaving the pipe to be closed. (France)

32106 TENTATIVE STANDARD FOR LAMINAR FLOW CLEAN AIR DEVICES. AACC CS-2T 1968. Boston; American Association for Contamination Control (1968). 20p. Available from American Association for Contamination Control, Boston.

A standard is presented which covers definitions, procedures for evaluating performance, and the major requirements of laminar-flow clean-air devices. A clean-air device is defined as a clean bench, clean work station, wall module, or other device (except a clean room) which incorporates at least one HEPA filter for the purpose of cleaning air supplied to a controlled work space. Laminar airflow is airflow in which the entire body of air within a confined area moves with uniform velocity along parallel flow lines. (L.C.L.)

32107 TENTATIVE STANDARD FOR HEPA FILTERS. AACC CS-1T 1968. Boston; American Association for Contamination Control (1968). 9p. Available from American Association for Contamination Control, Boston.

A standard is presented which covers the basic requirements of HEPA (high-efficiency particulate air) filters for use in clean air devices and in supply-air and contaminated-exhaust systems where extremely high collection efficiencies (99.7% or higher) for submicron particles is required. Three levels of performance and 3 grades of construction are included. This standard is intended as a basis for agreement between buyers and sellers. (L.C.L.)

32108 TENTATIVE STANDARD FOR TESTING AND CERTIFICATION OF PARTICULATE CLEAN ROOMS. AACC CS-6T 1970. Boston; American Association for Contamination Control (1970). 31p. Available from American Association for Contamination Control, Boston.

Methods are specified for the performance testing of air cleaning systems which use HEPA filters to achieve clean rooms. (L.C.L.)

32109 AMERICAN STANDARD: DESIGN GUIDE FOR A RADIOISOTOPE LABORATORY (TYPE B). ANSI N 5.2 1963. New York; American Institute of Chemical Engineers (1964). 18p. Available from American National Standards Inst., New York.

Recommendations are made for the essential features of a Type B laboratory in which radioisotopes are used. This standard does not prescribe detailed requirements for all possible isotope laboratories, but does identify the general requirements for the categories of radioisotope laboratories listed. The amounts and kinds of isotopes which can be safely handled in laboratories of various designs are categorized. The laboratory designation conveys the radiotoxicity of the isotopes involved and the maximum quantity which is to be manipulated. Some 100 isotopes in four hazard-potential categories are tabulated, as well as the type of laboratory identified with the amount and kind of isotope manipulated. The topics discussed include: general arrangements of facilities; construction; required building services, such as ventilation, waste disposal, and fire prevention facilities; and the laboratory work area. (L.C.L.)

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32110 ESTIMATING THE INHOMOGENEITY OF ABSORBED RADIATION DOSE ON IRRADIATING MATERIALS WITH ACCELERATED ELECTRONS. Chepel, L. V. At. Energ. (USSR); 30: 70-2(Jan 1971). (In Russian).

The depth of electron penetration should be close to the thickness of the irradiated material for the efficient use of fast electrons. However, in this case the inhomogeneity in dose distribution approaches 100%. To improve the situation it is necessary to irradiate from both sides, and to make multiple passes through the irradiator on thin layers of materials. The distribution of absorbed dose varies as a function of the range of the electron in the material being irradiated. The distribution of absorbed dose with thickness of the material is given in analytical form, and expressions are given for the absorbed dose as a function of the number of passes through the irradiator. The inhomogeneity in absorbed dose is less than 1% on irradiating a thin layer of material from both sides. (TTT)

32111 CENTRIFUGAL PUMPS. PTC 8.2 1965. New York; American Society of Mechanical Engineers (1966). 34p. Available from American Society of Mechanical Engineers, New York.

Standards are presented for conducting and reporting tests on centrifugal pumps, including those of the mixed flow and axial flow types. (L.C.L.)

32112 THERMAL INSULATION STRUCTURE FOR A WALL IN A FLUID MEDIUM. Thomas, Bernard Jean-Baptiste (to Sud-Aviation. Societe Nationale de Constructions Aeronautiques SA). French Patent 1,593,951. 1 Jun 1970. Filed 3 Dec 1968. (In French).

A structure for the thermal insulation of a wall in a liquid medium is presented. This structure consists of a bundle of hermetically sealed evacuated (or filled with a suitable fluid) tubular elements connected to their related elements by discontinuous junctions. The supporting elements are associated with the maintaining elements. They can be paired with the armatures. Equipment using such a system is presented (notably sodium-cooled fast reactors). (France)

32113 BYPASS AND DRAIN CONNECTION STANDARD. MSS Standard Practice SP-45 1953. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1953). 8p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented, for the design of valve and fitting drains, regardless of material or pressure, and fabricated bypasses for ferrous valves for all pressures wherever a bypass is required. The standard covers: standard symbols and locations of opening for drains and bypasses; standard size of drains and bypass openings; minimum thread lengths in drain and bypass tappings; minimum diameter and depth of socketweld connection for drain and bypass; butt-welding connection for drain and bypass; bosses for drain and bypass connection; and method of designating outlets of reducing fittings. (L.C.L.)

32114 150 LB CORROSION RESISTANT CAST FLANGES AND FLANGED FITTINGS. MSS Standard Practice SP-51 1949. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1957). 7p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the design of 150 lb cast flanges and flanged fittings, designated categorically as "corrosion resistant" and customarily made of austenitic types of stainless steel. The standard covers pressure-temperature rating, identification marking, material, dimensions and tolerances, facing finish, thread of screwed flanges, and gaskets. (L.C.L.)

32115 150 LB CORROSION RESISTANT CAST FLANGED VALVES. MSS Standard Practice SP-42 1949. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1959). 8p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the design of 150 lb cast flanged valves designated categorically as "corrosion-resistant" and customarily made of austenitic types of stainless steel. These valves are made with bolted bonnets, with the exception of the Y pattern swing check valve which is made with a threaded cap. The standard covers pressure-temperature ratings, identification markings, materials, facings, seats, dimensions and tolerances, gaskets, and bolting. (L.C.L.)

32116 HIGH PRESSURE CHEMICAL INDUSTRY FLANGES AND THREADED STUBS FOR USE WITH LENS GASKETS. MSS Standard Practice SP-65 1962. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1962). 8p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the design and testing of cast and forged steel flanges (welding neck and straight threaded) and threaded stubs particularly designed for end connections making use of lens gaskets. The standard covers a pressure rating of 6000 lb at 750°F, size, identification markings, materials for gaskets and valves, facings, welding end preparation, threads for screwed flanges, and testing. (L.C.L.)

32117 PIPE HANGERS AND SUPPORTS: MATERIALS AND DESIGN. MSS Standard Practice SP-58 1959. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1967). 12p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the material, design, and fabrication criteria to be used in the manufacture of standard types of pipe hanger components meeting designated minimum design working loads and temperature ratings. (L.C.L.)

32118 PIPE HANGERS AND SUPPORTS: SELECTION AND APPLICATION. MSS Standard Practice SP-69 1966. New York; Manufacturers Standardization Society of the Valve and Fittings Industry (1966). 11p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the selection and application of pipe hangers and supports for all service temperatures. Hangers and supports are of the types specified in MSS SP-58 Pipe Hangers and Supports–Materials and Design. Reference is also made to other pipe supporting and controlling elements such as guides, restraints, anchors, and sway braces. (L.C.L.)

32119 K-200 000 UNIVERSAL IRRADIATION UNIT. Goldin, W. A. (Inst. for Physical Chemistry, Moscow). Isotopenpraxis; 7: No. 2, 69(Feb 1971). (In German).

The design and operation of a large irradiation unit for radiochemical research at the Karpow Institute for Physical Chemistry are described. A combined activity of about 210,000 Ci results from the 60 standard ^{60}Co sources used in the device. (L.C.L.)

32120 ECONOMICAL EFFECTIVENESS OF THE USE OF GAMMA-RAY IRRADIATION UNITS OF THE KOLOS TYPE. Prokofev, N. S.; Kaushanskii, D. A.; Shukov, B. G. Isotopenpraxis; 7: No. 2, 68(Feb 1971). (In German).

The cost of using a portable irradiation unit of the Kolos type employing a ^{137}Cs gamma source for in-the-field irradiation of agricultural products was analyzed. The results were promising, and production of the irradiation units was recommended. (L.C.L.)

32121 GLANDLESS PUMPS IN C.E.G.B. POWER STATIONS. Barker, B.; Blackmore, R. H. (Central Electricity Generating Board, London). Combustion; 42: No. 11, 8-17(May 1971).

The selection and use of glandless pumps on certain hot water applications in C.E.G.B. power stations are discussed. For the duties concerned, high reliability with freedom from routine maintenance is important. In these instances the use of glandless pump units overcomes certain problems encountered which otherwise could detract from this aim, particularly with regard to pump glands where high pressures and temperatures are involved or where the exclusion of air ingress via the pump is desired. Applications are discussed in detail, followed by consideration of design requirements, features, and problems. Operating experiences are examined and reference is made to probable future trends. Mechanical and electrical aspects are also considered: The C.E.G.B. makes use of a large number of glandless pump motor units on a variety of applications in sizes ranging from 1 to 1600 hp. This application, however, is for pumps handling hot water for either feed heating, boiler feed, or boiler applications. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 32111 and 32112.

32122 (ANL–7762) VIBRATIONS AND STABILITY OF A TUBE CONVEYING FLUID. Chen, S. S.; Rosenberg, G. S. (Argonne National Lab., Ill.). Mar 1971. Contract W-31-109-eng-38. 49p. Dep. NTIS.

The free vibration, forced vibration, and parametric response of a simply supported tube conveying fluid are analyzed and the ef-

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fects of initial curvature and Coriolis force are included and evaluated. The equation of motion is formulated to incorporate initial curvature, damping, axial force, and unsteady flow. Galerkin's method is used to determine the free vibration by solving an algebraic characteristic equation; the forced vibration is reduced to a system of coupled ordinary differential equations. Excitation due to pulsating flow is also examined by means of Galerkin's method, which, in this case, yields a set of coupled Mathieu-Hill-type equations. The possibility of onset of a parametric behavior is demonstrated, and explicit formulas are obtained for the boundaries of the first two instability regions. Due to the presence of a Coriolis force, the system is characterized by a phase difference and mode coupling. The significance of the Coriolis force is discussed. The effect of initial curvature is analyzed, and wave propagation and vibrational problems in the media without flexural rigidity are also investigated in detail. (auth)

32123 (TRG-Report-2089) FURTHER EXPERIMENTS ON THE THERMAL BOWING OF SINGLE RODS SUPPORTED AT SEVERAL AXIAL POSITIONS. Rapier, A. C.; Jones, T. M. (United Kingdom Atomic Energy Authority, Sellafield (England). Reactor Group). 19 Oct 1970. 22p. Dep. NTIS (U. S. Sales Only). UK 16p.

Two types of experiment were carried out on elements with three different heat transfer surfaces: smooth, ribs transverse to the coolant flow, and ribs with a helix angle of 47°. In the first experiment, changes in surface temperature were measured when the elements were displaced parallel to the channel axis. In the second experiment, the development of bow was observed as the temperature difference between the surface and the coolant was increased. Values of the non-dimensional differential coefficient of heat transfer were derived independently from the two types of experiment and found to be in good agreement. The smooth surface, under the conditions tested, was found to be less unstable than previously predicted and measured, the transverse ribbed surface was just about as unstable as previously determined and the helical ribbed surface was inherently stable. (auth) (UK)

32124 MODEL OF TURBULENT VORTEX GENERATION IN BOUNDARY LAYER. Hokkyo, Noboru; Shimegi, Nobuo; Sumida, Isao (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: 106-7(Feb 1971).

An idealized model for turbulent vortex generation in the boundary layer of a flat plate is described. A relation between the flow velocity and the number of vortex strings created per unit time, identified with the frequency of pressure fluctuations, is proposed. The model can be used to further understanding of structural vibrations of reactor control rods and fuel elements caused by turbulent coolant flow. (J.R.D.)

32125 VELOCITY FIELDS IN TURBULENT FLOW PAST ROD BUNDLES. Subbotin, V. I.; Ushakov, P. A.; Levchenko, Yu. D.; Aleksandrov, A. M. (Inst. of Physics and Energetics, Obninsk, USSR). Heat Transfer - Sov. Res.; 3: No. 2, 9-35(Mar-Apr 1971).

Data are presented on an experimental and analytical study of velocity fields in rod bundles. Measured values of velocity fields, shear stresses, and hydraulic resistance (friction factors) were correlated and compared with existing results. Equations and reaction factors for various spacings (pitch) are given. Comparison with data for circular ducts is presented. (auth)

Isotope Technology

Refer also to abstracts 31897, 32069, 32079, 32081, 32086, 32087, 32094, 32109, 32119, 32120, 32152, 32166, 32225, 32371, 32469, 32488–32492, 32494, 32495, 32661, 33630, and 33922.

32126 (LA-4647) ^{238}Pu SPACE ELECTRIC POWER FUEL DEVELOPMENT PROGRAM. Quarterly Status Report, July 1–September 30, 1970. (Los Alamos Scientific Lab., N. Mex.). Mar 1971. Contract W-7405-eng-36. 18p. Dep. NTIS.

Modification of the fuel form from the original concept is reported. The new fuel form is designated plutonia molybdenum cermet (PMC). A new fuel characterization program is required by the change. Information is included on aspects of processing such as feed material preparation, particulate material coating, hot pressing methods development, and machining. Results are included on fuel compatibility with capsule materials, radiation effects on fuels, and physical properties of fuels. (J.R.D.)

32127 (MMM-3691-13) SNAP-21 PROGRAM, PHASE II. DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM: DYNAMIC LOAD CRITERIA STUDY. Wickenberg, R. (Minnesota Mining and Mfg. Co., St. Paul. Electric Products Group). 3 Mar 1967. Contract AT(30-1)-3691. 345p. Dep. NTIS.

A dynamic loading criteria study conducted as a part of the SNAP-21 development program is described. The study was conducted to establish the magnitude of dynamic loads that the SNAP-21 deep-sea radioisotope-fueled thermoelectric power system will experience during handling, transportation, implantment and recovery. In addition, the ability of the current 10-W SNAP-21 design to withstand these dynamic loads was analyzed and a parametric analysis conducted to determine what effect increasing system dynamic capability would have on system efficiency. It was found that shock loads during handling in terminals and during implantment could potentially be as high as 200 g's. The magnitude of these loads clearly indicated the need for shock attenuating structures for certain operations. The maximum shock loads that the system would experience in situations where shock attenuation was not practical was approximately 6 g's. Based on these findings, it was recommended that the existing SNAP-21 design specification be changed from the current shock requirement of 3 g's to 6 g's. The only system component requiring major redesign to achieve this higher dynamic capability is the insulation system. A method of increasing the insulation system dynamic capability by supplementing the existing radiation shield support with three tension tie rods was recommended. Design criteria for the shock attenuation capability of the shipping container and implantment structure were also established. (auth)

32128 (SC-RR-710012) LASL DART MINITHRUSTER SAFETY EVALUATION TESTS. Baker, F. L.; Cranfill, R. C.; Entrekin, J. L. (Sandia Labs., Albuquerque, N. Mex.). Feb 1971. 80p. Dep. NTIS.

Safety evaluation tests were performed on the LASL DART Minithruster to determine in a preliminary way the behavior of this device in a number of abort environments. The tests included overpressure, fragment impact, granite impact, air drop, and solid propellant fire. A description of each test and the results are presented. (auth)

32129 NEW SOURCES OF X RAYS. Tsukerman, V. A.; Tarasova, L. V.; Lodov, S. I. Usp. Fiz. Nauk; 103: 319-37 (Feb 1971). (In Russian).

A review is presented of x-ray sources developed during the past decade in various countries. These include impulse x-ray tubes, miniaturization of nano-second high-voltage equipment, and powerful impulse generators of hard Cherenkov radiation and relativistic electrons, which operate in the range 3 to 13 MeV at hundreds of kiloamperes. Also discussed are generators of flashes of soft x rays from discharge through air, He, H_2 etc. Low-energy radioactive sources of x and γ radiation such as $^{51}_{23}$V, $^{55}_{26}$Fe, $^{238}_{94}$Pu, and $^{241}_{95}$Am, permit the design of small portable research instruments. 79 references (K.S.W.)

32130 ABNORMAL DECAY CHARACTERISTICS OF A REPLACEMENT ^{60}Co TELETHERAPY SOURCE. Jackson, Herbert L.; Marschke, Charles H. (Univ. of Iowa, Iowa City). Health Phys.; 20: 353-7(Mar 1971).

The exposure rate of a 3000 R/min ^{60}Co source, constructed by using pellets of high and low specific activity in discrete blocks, over the first year of use was determined and is reported. An initial rapid decline of exposure rate in the first 100 days was followed by an abnormally slow decrease in output from the 150 to 250th day. Subsequently a smaller variation from rapid to slow decline was measured. It is suggested that the only plausible explanation is that the pellets of high and low activity become intermixed due to jolting of the source when it was exposed and then shuttered in use. It is concluded that the design of such therapy sources should be reconsidered and that the output should be calibrated continuously. (UK)

32131 NATIONAL USES AND NEEDS FOR STANDARD RADIOACTIVE MATERIALS. Washington, D. C.; National Academy of Sciences (1970). 12p. Available from National Academy of Sciences, National Research Council, Washington, D. C.

An investigation of the status of and need for radioactivity standards, conducted by the Committee on Nuclear Science of the National Research Council, is reported. The uses of radioactivity standards in public health, medicine, and nuclear science are discussed. The availability of and users' complaints about standards are included. It is recommended that: the US government appoint one agency, e.g., the National Bureau of Standards, as the central supplier of radioactivity standards; that agency have long-term funding to perform the research and services necessary for providing and promoting the use of standards of from 1 to 3% accuracy; and commercial suppliers should be encouraged to specialize in the preparation of custom (i.e., unusual)

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standards, standards of from 3 to 10% accuracy, and calibrated sources. (L.C.L.)

32132 SPECIFICATION OF HIGH ACTIVITY GAMMA-RAY SOURCES. ICRU Report 18 1970. Washington, D. C.; International Commission on Radiation Units and Measurements (1970). 26p. Available from ICRU Publications, Washington, D. C.

Standards for high-activity gamma sources for use in teletherapy, radiography, and research and industry, and the recommended bases for source specifications are discussed. Terms to be used in specifications for these three sources and methods for standards verification are recommended. (L.C L.)

32133 TIMEPIECE DRIVEN BY NUCLEAR ENERGY. Adler, Karl; Ducommun, Georges (to Baumgartner Freres SA). U. S. Patent 3,562,613. 9 Feb 1971. Priority date 17 Apr 1968, Switzerland.

A timepiece driven by nuclear energy is described. The radiation of a radioactive source serves at the same time for producing the electric power for energizing a counting circuit and for control of a counting frequency or recombination frequency determining the advance of the timepiece. (Official Gazette)

32134 SAFE DESIGN AND USE OF INDUSTRIAL BETA-RAY SOURCES. National Bureau of Standards Handbook 66. ANSI Z 54.2 1958. Washington, D. C.; National Bureau of Standards (1958). 33p. Available from Superintendent of Documents, GPO, Washington, D. C.

A guide for the safe design, manufacture, installation, use, maintenance, and disposal of sealed beta sources for industrial applications is presented. (L.C.L.)

32135 USE OF LOW RADIOACTIVE LABELING TECHNIQUE IN THE MEASUREMENT OF PISTON RING WEAR. Tao, Kuoting; Yang, Teh-li (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 7: No. 3-4, 32-8(Oct 1970).

An activation analysis technique was developed for measuring piston ring wear. The method utilized an irradiated piston ring. Oil samples were taken at predetermined intervals and irradiated in a reactor. The difference in iron contents in oil samples of two runs was used as an indication of piston ring wear. The method was designed for low radiation exposure, small amount of radioactive waste, and to get the wear rate in a reasonably short time. The experimental results show that this technique is feasible. (auth)

32136 RECOMMENDED PRACTICE FOR CALCULATION OF ABSORBED DOSE FROM GAMMA RADIATION. ASTM D 2568-70. Philadelphia; American Society for Testing and Materials (1970). 6p. Available from American Society for Testing and Materials, Philadelphia.

A technique is presented for calculating the dose or energy absorbed in a material from knowledge of the gamma radiation field and the composition of the material. The procedure is also applicable for x radiation and electrons provided the effective energy of the beam is known and falls within the range from 0.10 to 3.0 MeV. From the absorbed dose in one material, the absorbed dose in any other material exposed to the same radiation field may be calculated. The procedure is restricted to use within the above mentioned energy range and with materials composed of the elements: H, C, O, F, Si, N, S, Cl, and P. (L.C.L.)

32137 USA STANDARD: CLASSIFICATION OF SEALED RADIOACTIVE SOURCES. ANSI N 5.10 1968. New York; American Institute of Chemical Engineers (1968). 10p. Available from American National Standards Inst., New York.

This standard classifies sealed radioactive sources according to particular uses. The classification is based on radiotoxicity, Curie content, and performance requirements. The standard does not attempt to establish design standards, but leaves the design features to the judgement of the supplier and user, provided that the performance requirements are met. (L.C.L.)

32138 STUDY OF THE POSSIBILITIES OF SURVEYING OIL WELLS WITH THE USE OF A Ge(Li)-GAMMA DETECTOR AND A Po–Be NEUTRON SOURCE. Govor, L. I.; Demidov, A. M.; Ivanov, V. A. At. Energ. (USSR); 30: 66-9(Jan 1971). (In Russian).

A model of an oil well was set up in a tank 800 × 800 × 700 mm. The steel tube had an inner diameter of 150 mm with a wall thickness of 10 mm, while the cement ring around the steel tube was about 35 mm thick. The tank was filled with freshwater, transformer oil, or dry sand saturated with freshwater or oil. The Ge(Li) gamma detector shielded with lead had a sensitive volume of 2.5 cm^3, and was placed inside the steel tube. The Po–Be source had an activity of 2 to 3 × 10^7 neutrons/sec. The distance between the detector and neutron source was about 200 mm. Elements such as silicon, calcium and hydrogen can be identified from the gamma radiation after thermal neutron capture (4.936 MeV ^{29}Si, 6.420 MeV ^{41}Ca and 2.223 MeV ^{2}H). Oxygen-16 and carbon-12 were detected from the gamma radiation after inelastic scattering of fast neutrons on these nuclei (6.131 MeV gamma for ^{16}O and 4.43 MeV gamma for ^{12}C). In preliminary experiments with a dry well without a cement ring it was possible to detect peaks from ^{1}H, ^{28}Si and ^{56}Fe as a result of inelastic scattering of fast neutrons. The ^{12}C gamma lines were observed on surrounding the detector and neutron source with paraffin. From ratio intensities of the gamma lines it is possible to determine the concentration of hydrogen in the surrounding medium. The 6.131 MeV peak of ^{16}O was observed. The 4.43 MeV peak was the most reliable indicator of the presence of oil after taking into account the peak due to thermal neutron capture by iron. (TTT)

32139 MRKh-γ-25M TYPE ISOTOPIC γ-RAY SOURCE FOR MICROBIOLOGICAL RADIATION-CHEMICAL INVESTIGATIONS. Kaushanskii, D. A. At. Energ. (USSR); 30: 83-5(Jan 1971). (In Russian).

A compact microbiological and radiation-chemical γ radiation source that may be used in an ordinary chemical or biological laboratory to carry out experiments under static, flow-through or circulating conditions within a broad temperature and pressure range, from −40 to +550°C and 10^{-5} mm of Hg to 100 atm has been built. The unit may also be used to sterilize vaccines, to prepare them by the radiative inactivation of organisms, to sterilize sera and microbial antigens. The irradiator may be loaded with ^{60}Co source within the dose range from 2300 to 16,200 Ci. The maximum dose rate in air, at the center of the irradiation chamber was 2 × 10^6 R/hour. Special double switches were used to ensure the proper positioning of the operating chamber with respect to the irradiator. In order to maintain the initial dose rate, additional source material must be added to the unit every five years. The prototype was placed in operation during August 1969; since 1970 the unit is in mass production. (TTT)

32140 CONTINUOUSLY OPERATING γ-RADIATION SOURCES FOR CARRYING OUT LIQUID- AND GAS-PHASE PROCESSES. Gol'din, V. A.; Breger, A. Kh.; Mendel'son, E. L.; (and others). At. Energ. (USSR); 30: No. 1, 81-3(Jan 1971). (In Russian).

A prototype, continuous ^{60}Co source, designated as RKhUND-20000 and intended for radiation-chemical processes at a quasi-industrial scale has been built. The device consists of a squirrel-cage type container, a control pipe, a movable, 3-section cylinder, a locking device, and a lifting system. The irradiator, built of 20 individual curved channels, contain 80 standard ^{60}Co preparations; the remaining free volume is filled with iron shot. The sectional cylinder has a central chamber for positioning the reaction vessel and an upper and a lower, lead-shielded plugs. Magnetic shutters ensure protection of the personnel. A check of the biological shield indicated that the dose rate dose not exceed the calculated 0.6 μR/sec dose rate. The unit is loaded directly by the "dry" method using the ^{60}Co preparation from the shipping container. An improved version of the source provided with external supplementary ^{60}Co units made it possible to increase the γ radiation efficiency. (TTT)

32141 RADIOACTIVE METHODS IN PROCESS CONTROL. Winkhaus, G. (Vereinigte Aluminium-Werke AG, Bonn). pp 361-6 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

The different methods using radioisotopes for the measurement, regulation and control of industrial production are described and, in particular, details are given on the use of the isotopes ^{24}Na and ^{140}La to follow the course of processing in bauxite digestion plants. A brief indication is also given of how radioactive methods could also be usefully applied in the control of the electrolytic reduction process. (auth)

32142 FABRICATION OF THIN RADIOACTIVE SOURCES USING BIOLOGICAL STAINING TECHNIQUES. O'Brien, P.; McNelles, L. A.; Campbell, J. L.; Jordan, D. C. (Univ. of Guelph, Ont.). Nucl. Instrum. Methods; 93: No. 1, 173-4(1971).

Thin ^{191}Os sources have been made by the selective staining technique used to prepare biological materials for electron microscopy. The technique may be used for various heavy metal compounds. (auth)

32143 ISOTOPIC TECHNIQUES IN THE STUDY AND CONTROL OF ENVIRONMENTAL POLLUTION. Mott, W. E. (Atomic Energy Commission, Washington, D. C.). pp 3-46 of Nuclear

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Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The application of isotopic techniques to problems directly related to environmental pollution began in the United States some 15 years ago. Since then, environmentally-oriented studies involving isotope-based techniques have grown steadily, although not dramatically, in number and scope. Gradually, these studies have become aimed more at obtaining an understanding of specific environmental problems rather than merely obtaining an evaluation of the potential value of a given technique. Also, more and more they are being generated and conducted by the environmentalist and the sanitary engineer rather than by the isotope technologist as in the past. The work performed with isotopes in the environmental pollution area in the United States in the last five years is reviewed. The major topics covered are isotopic tracers, radioisotope instruments, X-ray fluorescence analysis, neutron activation analysis, radio-release, Mössbauer spectrometry and the radiation treatment of municipal and industrial wastes. (auth)

32144 USE OF RADIONUCLIDES TO EVALUATE THE TRANSPORT OF POLLUTANTS FROM THE HYDROSPHERE INTO THE ATMOSPHERE. Wilkniss, P. E.; Bressan, D. J. (Naval Research Lab., Washington, D. C.). pp 297-307 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Man-made pollutants discharged into rivers, lakes and oceans can migrate into the atmosphere by various mechanisms. The bursting of small air bubbles at the ocean surface plays a major role in the transport of inorganic and organic materials from the oceans into the atmosphere. On bursting at the surface, an air bubble ejects tiny droplets of water into the air. Many of these droplets are small enough to remain airborne as an aerosol and thus account for most of the transport of non-aqueous materials from ocean to atmosphere. This bubble bursting process can be duplicated in the laboratory. Especially when radioactively-labeled elements or compounds are employed one can use this process to evaluate easily the transport of many pollutants from different water masses into the atmosphere. The resulting aerosols are useful for studying the behavior of the contained pollutants in the atmosphere. Artificial and environmental water samples were labeled with the radionuclides ^{18}F, ^{24}Na, ^{38}Cl and ^{42}K. Air was bubbled through these water samples and the aerosols formed from the bubble bursting were collected and counted by gamma-spectrometry. The results indicate that the bubble-bursting process provides an excellent method for producing multi-labeled aerosols. The chemical composition of these aerosols depends on the composition of the original solution. Stable, labeled aerosols were prepared in the laboratory under conditions closely resembling those found in the environment. Implications for pollution studies are: the transport of dissolved inorganic or organic pollutants and surface active films (organo-phosphorus compounds, oil spills) from a water mass into the atmosphere can be investigated. Aerosols containing labeled pollutants can be produced and used in air-chemistry studies. The method is applicable to evaluation of water purification by distillation techniques in which bubble-bursting processes are also important. (auth)

32145 USE OF RADIONUCLIDES FOR TRACING THE ORIGIN OF MARINE OIL POLLUTION. Carlsson, S.; Liden, K.; Bertil, R.; Persson, R. (Lund Univ., Sweden). pp 361-9 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

A method using radionuclides to identify the origin of oil pollution of the sea caused by ships is described. The method is based on the possibility of labeling the oil on a ship with two or more radionuclides having different half-lives. Experiments on ships have been performed using the iodine isotopes ^{125}I ($T_{\frac{1}{2}}$ = 60 day) and ^{131}I ($T_{\frac{1}{2}}$ = 8 day) at a concentration of 0.5 to 3 $\mu Ci/m^3$ of oil. Several ships can be labeled simultaneously if different concentration ratios of $^{131}I/^{125}I$ are used. The activity ratio of the polluted oil is then determined, enabling a simple dating and identification to be performed. Successful results have been obtained in a series of about 30 ship-labelings. The stability of the labeled oil has been studied in laboratory and field experiments. Washing with water at 100°C or a 7-day exposure to open air on a seawater surface showed that 20 to 30% of the labeling radionuclides leached out of the oil during these procedures, and that the activity ratio was not affected. A good mixing homogeneity of the labeling substance in the oil has been obtained in ships tanks and in a power-plant fuel tank. The overall dating accuracy of the experimental series was ±15 hr (1 S.D.). This figure can be reduced by improving the measuring technique. (auth)

32146 PURITY TESTS OF A ^{68}Ge–^{68}Ga GENERATOR. Barrall, R. C.; Chakalian, V. M.; Colombetti, L. G.; Finston, R. A. (Stanford Univ., Calif.). Int. J. Appl. Radiat. Isotop.; 22: 149-54(Mar 1971).

Gallium-68 is a useful tracer that has many possible applications in nuclear medicine. Its short half-life of 68 min permits relatively large amounts to be used while maintaining an acceptable radiation dose to the patient. Leakage of the 280 day half-life parent isotope, ^{68}Ge, could result in a much larger radiation dose. Generator eluates were analyzed by γ spectroscopy to determine radioactive impurities. Germanium-68 was the only additional radioisotope found. The measured leakage of ^{68}Ge was used in calculating the relative patient dose from the ^{68}Ga and ^{68}Ge. If ^{68}Ga is administered soon after milking the generator, leakage of ^{68}Ge contributes no more than 25% additional radiation exposure than ^{68}Ga alone. However, with each 68-min delay in administration, the relative contribution of ^{68}Ge doubles. (auth) (UK)

Materials Testing

Refer also to abstracts 32194, 32195, 32658, 32868, and 32869.

32147 (RD/B/N-1838) STRESS INTENSITY FACTORS FOR CURVED NOTCHES IN LONGITUDINAL SHEAR. Tucker, M. O. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Nov 1970. 24p. (RPC(GP)/P-(70)34). Dep. NTIS (U. S. Sales Only).

Closed expressions are presented for Mode III stress intensity factors for isotropic elastic half-spaces containing certain curvilinear notches and surface features. The results may be applied to the fracture strength of HTR fuel compacts. (UK)

32148 STANDARD METHOD OF MAGNETIC PARTICLE TESTING AND INSPECTION OF HEAVY STEEL FORGINGS. ASTM A 275-68. Philadelphia; American Society for Testing and Materials (1968). 7p. Available from American Society for Testing and Materials, Philadelphia.

A procedure for magnetic particle inspection of steel forgings is specified. The procedure will produce consistent results upon which acceptance standards can be based. (L.C.L.)

32149 STANDARD METHOD AND SPECIFICATION FOR LONGITUDINAL-WAVE ULTRASONIC INSPECTION OF STEEL PLATES FOR PRESSURE VESSELS. ASTM A 435-67. Philadelphia; American Society for Testing and Materials (1969). 2p. Available from American Society for Testing and Materials, Philadelphia.

The examination procedure and acceptance standards are presented for pulse–echo ultrasonic inspection of rolled carbon and alloy steel plates, 3/4 in. (19.05 mm) in thickness and over, of fully–killed pressure vessel quality. This standard was developed to assure delivery of steel free from gross internal discontinuities such as pipe, ruptures or laminations and is to be used whenever the inquiry, contract, order or specification states that the plates are to be subjected to ultrasonic inspection. (L.C.L.)

32150 RECOMMENDED PRACTICE FOR ULTRASONIC TESTING AND INSPECTION OF HEAVY STEEL FORGINGS. ASTM A 388-67. Philadelphia; American Society for Testing and Materials (1967). 6p. Available from American Society for Testing and Materials, Philadelphia.

Examination procedures are recommended for the pulse-echo ultrasonic inspection of heavy steel forgings by longitudinal and angle beam techniques. This standard is to be used whenever the inquiry, contract, order, or specification states that forgings are to be subjected to ultrasonic inspection in accordance with ASTM Specification A 388. (L.C.L.)

32151 RECOMMENDED PRACTICE FOR RADIOGRAPHIC TESTING. ASTM E 94-68. Philadelphia; American Society for Testing and Materials (1968). 18p. Available from American Society for Testing and Materials, Philadelphia.

A guide for satisfactory radiographic testing is presented. Topics discussed include; types of materials to be inspected; radiographic testing techniques and production methods; radiographic film selection, processing, viewing, and storage; and maintenance

of inspection records. Within the present state of the radiographic art, this recommended practice is generally applicable to all available materials, processes, and techniques. No attempt is made to set up acceptance standards for any material or production process, and the problems of personnel protection against x rays and gamma rays are not included. (L.C.L.)

32152 IMPROVEMENTS TO SOURCE HOLDERS FOR GAMMAGRAPHIC APPARATUS. (to Compagnie Generale de Radiologie. Robatel-SLPI,SA). French Patent 1,600,510. 27 Jul 1970. Filed 18 Nov 1968. (In French).

This apparatus is provided with signal contacts, which enable the operator to verify at any moment the position of the source holder. A visual or audio signal indicates when the source holder is well inside the projector at the end of the operation. This signal is controlled by the displacement of a mobile part which is itself actuated by a stop fixed to the projector cable. The improvements brought about by this invention ensure complete safety, the signal being actuated only when the source holder is completely inside the projector. (France)

32153 RADIOGRAPHIC QUALITY STANDARD FOR STEEL CASTINGS FOR VALVES, FLANGES, FITTINGS, AND OTHER PIPING COMPONENTS. MSS Standard Practice SP-54 1959. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1960). 4p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard method is presented for the radiographic inspection of steel castings, either as-cast or after welding to repair casting defects. The purpose of the guide is to provide a standard practice which will limit the number of possible variables in the procedure. Among the variables specified are: x-ray or gamma-ray intensity; types of castings to be radiographed; number and size of radiographs required; specimen preparation and thickness; area to be radiographed; and film and equipment to be used. (L.C.L.)

32154 QUALITY STANDARD FOR STEEL CASTINGS FOR VALVES, FLANGES, AND FITTINGS AND OTHER PIPING COMPONENTS (VISUAL METHOD). MSS Standard Practice SP-55 1961. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1961). 17p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard of acceptability for visual inspection of surfaces on steel castings for values, flanges, and fittings is presented. A series of reference photographs typical of the various surface irregularities common to steel pressure castings and illustrations of generally acceptable and generally rejectable quality are provided. (L.C.L.)

32155 HYDROSTATIC TESTING OF STEEL VALVES. MSS Standard Practice SP-61 1961. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1961). 6p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the hydrostatic seat and shell pressure testing of steel angle, check, gate, and globe valves designed and made of materials to merit the rating established in American Standard ASA B16.5-1957. (L.C.L.)

32156 QUALITY STANDARD FOR STEEL CASTINGS FOR VALVES, FLANGES, AND FITTINGS AND OTHER PIPING COMPONENTS (DRY POWDER MAGNETIC PARTICLE INSPECTION METHOD). MSS Standard Practice SP-53 1957. Arlington, Va.; Manufacturers Standardization Society of the Valve and Fittings Industry (1958). 6p. Available from Manufacturers Standardization Society of the Valve and Fittings Industry, Arlington, Va.

A standard is presented for the magnetic particle inspection of steel castings for valves, fittings, flanges, and other piping components. Such inspection is primarily intended for use to insure that such components in oil refinery use, under stipulated pressure and temperature conditions, meet safety code requirements. (L.C.L.)

32157 CHOICE OF TESTING CONDITIONS FOR GAMMA RADIOMETRY METHODS. Godlewski, Z. (Inst. for Electrotechnics, Warsaw). Non-Destruct.-Test.; 4: No. 2, 126-32 (Apr 1971).

The kinetic, geometric and radiological factors affecting the detection of flaws are discussed theoretically and checked against experimental results. The results obtained from each method proved to be almost identical. (auth) (UK)

Protective Structures

Refer also to abstract 33319.

Radioactive Material Handling

Refer also to abstracts 32095, 32670, and 33928.

32158 (CONF-700541) INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT ELEVENTH ANNUAL MEETING, MAY 25–27, 1970. (Institute of Nuclear Materials Management, Columbus, Ohio). 420p. H. L. Toy, Columbus, Ohio. $7.50.

Twenty-three papers on nuclear materials management were presented at the conference. A separate abstract was prepared for each of 21. Two papers appeared previously in NSA as 25: 4257 and 25: 8448. (L.C.L.)

For abstracts of individual papers see: 32159–32179.

32159 (CONF-700541–, pp 5-20) ACCOUNTABILITY AND SAFEGUARDS SYSTEM FOR THE REACTOR OPERATOR. Soucy, A. R. (Yankee Atomic Electric Co., Westboro, Mass.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The future role of electric power companies in safeguarding special nuclear materials is discussed. Present methods used at the Yankee Atomic Electric Co. for accounting for and safeguarding its inventory of nuclear materials are described. It is concluded that with the predicted increase in commercial operation of nuclear power reactors, public utility companies will own or possess more special nuclear material than any other group in the nuclear industry, and that the experience of these companies with state and federal regulatory agencies has developed a disciplined approach to precise accounting and control procedures which will be advantageous when applied to the safeguarding of nuclear materials. (L.C.L.)

32160 (CONF-700541–, pp 21-32) AEC EXPERIENCE WITH ON SITE CONTRACT ADMINISTRATION OF NUCLEAR FUEL. Donovan, William P.; Gundersen, Gordon E.; Lang, Raymond E. (Chicago Operations Office (AEC), Ill.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The experience of the AEC Chicago Operations Office in conducting a materials control program during the production, shipping, fabrication, transport, use, and recovery of plutonium fuel for the ZPPR is described. The following aspects related to nuclear materials management and safeguards are included: contract clauses; role of the resident inspector; material receipt procedures; control of material in process; scrap recovery; and inventory activities. It is recommended that a project-oriented on-site representative replace the on-site-oriented inspector in order to achieve a unified project-oriented safeguards system. (L.C.L.)

32161 (CONF-700541–, pp 33-42) KENTUCKY'S POSITION IN PRODUCING AND PROCESSING NUCLEAR FUELS. Plock, Gene (Kentucky Dept. of Commerce, Frankfort).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The role of the state of Kentucky in further developing uranium enrichment facilities at Paducah, in producing greater coal supplies for out-of-state enrichment facilities, in possibly using the high temperatures available in reactors for refining coal, and the advantages in the state relative to future nuclear power plant development are discussed. (L.C.L.)

32162 (CONF-700541–, pp 45-55) REMARKS BY CONGRESSMAN CRAIG HOSMER BEFORE THE ELEVENTH ANNUAL MEETING OF THE INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT, GATLINBURG, TENNESSEE. Hosmer, Craig (Joint Committee on Atomic Energy (U. S. Congress)).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The development of methods in the US for accounting for nuclear materials is described. The role of the IAEA in implementing national and international safeguards systems is dis-

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cussed. Potential hazards from inadequate safeguards programs are illustrated. Suggestions are made for increasing the effectiveness of safeguards organizations by closer cooperation with existing police-type organizations. (L.C.L.)

32163 (CONF-700541–, pp 56-69) COMPUTER PROGRAMS FOR SAFEGUARDS AND NUCLEAR MATERIALS MANAGEMENT AT BATTELLE–COLUMBUS PLUTONIUM LABORATORY. Ridihalgh, John L. (Battelle Memorial Inst., Columbus, Ohio).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The development, since 1968, of a computerized system for nuclear materials control at Battelle's Plutonium Laboratory is described. The program requirements, operational difficulties of a computerized system for a research laboratory, and the system's ability to meet the demands of safeguards and nuclear materials management are emphasized. (L.C.L.)

32164 (CONF-700541–, pp 71-84) CONTROL DESIGN FOR PLUTONIUM COUNTING SYSTEMS. Doher, L. W.; McBride, J. D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

A design is described which assures control of the Pu counting systems used at Rocky Flats Plant to measure solid Pu in waste and process materials, while establishing measurement bias and variability information for process control and inventory management. (auth)

32165 (CONF-700541–, pp 85-100) INTEGRATED SYSTEM OF NUCLEAR MATERIALS CONTROL AT OAK RIDGE NATIONAL LABORATORY. Cardwell, R. G.; Foster, B. E.; Gower, J. C. (Oak Ridge National Lab., Tenn.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Current emphasis on development of fuels for breeder reactor application has necessitated frequent intermixing and copressing of ^{233}U, ^{235}U, and ^{239}Pu isotopes. To provide the highly accurate control system that assures safe operation of the facilities, all criticality, accountability, and radiation safety controls were integrated into a centralized system managed by a coordinator designated the Nuclear Materials Controller. Emphasis was placed on minimizing the spread of contamination and reducing the potential for a nuclear incident while at the same time maintaining a smooth, uninterrupted flow of materials with a minimum of paper work. The centralized system is composed of three integrated units: the Criticality Control Board—a visible, current record of all nuclear materials under control of the system, with magnetic, color-coded indicators that reflect values, location, and type of isotope in each approved laboratory to the nearest $\frac{1}{2}$ g; the Nuclear Materials Flowboard—a modified, color-coded, industrial indicator that visibly reflects each temporary movement of the materials and their current location during processing; and the Flip-Sheet Ledger system—a concise version of the columnar accounting sheet that permits a great number of accounts to be filed and worked on overlays in an $8\frac{1}{2} \times 11$-in. ledger book. The system has effectively and efficiently met all control requirements and provided both necessary and desirable safeguards without hindering the processing of materials; in several instances it has expedited production. The detailed records of materials on hand by type and location provide a detailed, current inventory that has resulted in savings of time and money on materials procurement and that has brought to attention valuable, inactive quantities that could be returned to production channels. (auth)

32166 (CONF-700541–, pp 101-21) USE OF CALORIMETRY IN NUCLEAR MATERIALS MANAGEMENT. Nutter, James D.; O'Hara, F. A.; Rodenburg, W. W. (Mound Lab., Miamisburg, Ohio).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The development and use of calorimeters for measuring the mass of a particular isotope in a material sample are described. A detailed example is given of how calorimetry is used at Mound Laboratory to follow the fuel for the SNAP-27 heat source through the ^{238}Pu fuel fabrication process. It is concluded that calorimetry is nondestructive, simple to operate, rugged, accurate, and precise. (L.C.L.)

32167 (CONF-700541–, pp 122-39) WIDESPREAD NEGLECT OF THE INPUT CYCLE IN BUSINESS-SYSTEMS. Kaiser, Ronald L. (Atomic Energy Commission, Washington, D. C.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Neglect of the input cycle in business computer systems is discussed with illustrative examples. Characteristics of a good input cycle, both the often overlooked as well as the commonly recognized characteristics, are listed as a guide for developing new systems or for analyzing the input portion of existing systems. The role of the operator-user and personnel responsible for the input cycle in supplying the management interest, support, and attention needed for assuring a good input cycle is emphasized. (L.C.L.)

32168 (CONF-700541–, pp 140-52) LIMITS OF ERROR MODEL FOR A $PuO_2 + UO_2$ FUEL FABRICATION INVENTORY. King, Robert H.; Conroy, Bartley W.; Moss, H. Donald (Westinghouse Electric Corp., Pittsburgh, Pa. Nuclear Fuel Div.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

A mathematical model is presented for calculating the "limits of error" associated with the material balance of special nuclear materials after a physical inventory. Data are presented for one inventory involving a single account, i.e., the Pu inventory in the Plutonium Recycle Program at the Westinghouse Plutonium Fuels Development Laboratory. By using the model to analyze the components of this inventory system which could contribute to inventory error, it was concluded that the material unaccounted for (MUF) was negligible and the inventory was accepted. (L.C.L.)

32169 (CONF-700541–, pp 153-65) UPDATING OF THE NEW LOOK IN SAFEGUARDS. Crowson, Delmar L. (Office of Safeguards and Materials Management (AEC), Washington, D. C.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Efforts to create improved safeguards systems which are effective, inexpensive relative to the cost of the material involved, and which create a minimum of interference with normal plant operation have resulted in improved practices for materials control, materials accounting, surveillance, and containment. The development of equipment and methods for nondestructive assaying of special nuclear materials is considered satisfactory. Further improvements are needed in the capability to deter diversion and to promptly detect diversion when it occurs. AEC programs being conducted to upgrade safeguards against unlawful diversion of special nuclear materials are described. The development of nuclear facilities design criteria which will result in improved safeguards capabilities is mentioned. (L.C.L.)

32170 (CONF-700541–, pp 166-76) DIVISION OF NUCLEAR MATERIALS SAFEGUARDS–THE SECOND YEAR. D'Amico, Vincent J.; Page, Ralph G. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The USAEC Division of Nuclear Materials Safeguards licenses and inspects users of special nuclear materials to assure user compliance with safeguards requirements. Experience during the second year of operation of this division is reviewed. The inspection program is summarized, and new requirement amendments issued during the year are listed. It is concluded that licensee management supports and will work toward further strengthening of an effective safeguards program. (L.C.L.)

32171 (CONF-700541–, pp 177-89) SNM MEASUREMENT ERRORS BASED ON SAFEGUARDS INVENTORY VERIFICATION DUPLICATE SAMPLES. Ong, L. D. Y.; Cohen, I.; Hind, J. A.; Miraglia, F. J. Jr. (Division of Nuclear Materials Safeguards (AEC), Washington, D. C.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The presence of "noise" due to measurement uncertainties at times makes it difficult for a safeguards system to determine how well material is being accounted for. Only by identifying and con-

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trolling the masking effect of this background "noise" can one determine the significance of apparent losses of material. A simple replicate sampling approach is described which is useful for determining systematic and random errors associated with SNM quantities. The Division of Nuclear Materials Safeguards' experience in implementing this sampling method for verifying inventories at licensee facilities is discussed. The general inspection procedure of the Division is reviewed, and a summary of systematic and random errors observed at certain licensee facilities is presented. (auth)

32172 (CONF-700541–, pp 190-211) GENERALIZED PROPAGATION OF ERROR USING A NEW APPROACH. Lieblien, Julius (National Bureau of Standards, Washington, D. C.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Propagation of error formulas for the case of one function of several variables or several explicitly known functions were studied. The only untreated case remaining is the one where the "dependent" variable is an implicit function and cannot readily (or not at all) be solved in terms of the independent variables. This case which takes the general matrix viewpoint and thereby obtains results in concise form is described. A special case is the application to linear (algebraic) systems arising in an idealization of a nuclear process flow, without the necessity for obtaining the explicit solution. (auth)

32173 (CONF-700541–, pp 255-65) INTEGRATED SAFEGUARDS EXPERIMENT. Suda, S. C. (Brookhaven National Lab., Upton, N. Y.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The Integrated Safeguards Experiment, scheduled for completion in June 1971, is described. This program is designed to test the usefulness to safeguards of materials balance accounting techniques which employ data based completely on measurements. The experiment should: evaluate the impact of new nondestructive measuring methods on materials balance accounting; study new methods for measurement data acquisition and processing; evaluate the accuracy and timeliness of currently employed chemical analysis and sampling methods; and determine the magnitude of unidentified process losses and methods for reducing these losses. The systems studies plan for performing each of the three phases in the program is outlined. (L.C.L.)

32174 (CONF-700541–, pp 266-80) NONDESTRUCTIVE ASSAY OF PLUTONIUM FUEL PLATES. Kormuth, J. W.; Gettings, J. F.; James, D. B. (Nuclear Materials and Equipment Corp., Apollo, Pa.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The equipment and method used for nondestructive assaying of the ^{239}Pu and ^{241}Pu content in stainless steel-clad plutonium fuel plates are described. The plates were fabricated in five different designs, but were of the same core composition. 1700 plates were fabricated. Basically the method involved monitoring the gamma radiation in the 371-to-468 keV range emanating from the ^{239}Pu and analysis of the ^{241}Pu by integration of the 208 keV photopeak of ^{237}U which is in secular equilibrium with ^{241}Pu. The total nondestructive assay results were compared with the chemical analyses of the melts and showed a difference of ±0.08%. Single fuel plates were used as samples for total dissolution and chemical analysis and resulted in a ±0.6% difference between the nondestructive and chemical assays. (L.C.L.)

32175 (CONF-700541–, pp 281-315) PASSIVE MEASUREMENTS OF WASTE IN 55 GAL DRUMS AND CONCENTRATED SCRAP IN 2 1 BOTTLES. Zucker, M. S.; Weinstock, E. V. (Brookhaven National Lab., Upton, N. Y.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Field measurements of plutonium-bearing waste and scrap using elementary passive techniques are reported. The measurements were conducted at the NFS Erwin, Tenn. facility. First, the equipment, method, and results are described for neutron well counter measurements of the Pu content in Pu-bearing scrap with the Pu having an accurately known isotopic composition. The material ranged from pure mixed oxide sintered pellets to mixed oxide powder on some diffuse substrata. Second, neutron and gamma measurements were made on drum-contained liquid and solid wastes and on box-contained solid waste. These wastes were categorized according to physical form and the amount of Pu thought to be present on the basis of earlier assays. The results of these scrap and waste measurements indicated that systematic errors are generally more significant than statistical errors and must be evaluated experimentally and/or theoretically, and that waste should be packaged in smaller than 55 gal units in order to improve the accuracy of and the time consumed in assaying the major constituents in the waste. (L.C.L.)

32176 (CONF-700541–, pp 316-47) NEUTRON INTERROGATION TECHNIQUES FOR FISSIONABLE MATERIAL ASSAY. Menlove, H. O.; Augustson, R. H.; East, L. V.; Evans, A. E.; Keepin, G. R. (Los Alamos Scientific Lab., N. Mex.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The nondestructive assaying of fissionable materials is vital to nuclear safeguards and to efficient nuclear materials management. Active assay techniques involving the use of interrogating neutrons or photons to induce fission or capture reactions in the assay samples and passive techniques using gamma-ray scanning of samples are described. These techniques have been applied to a wide range of fissionable samples varying from small fuel pellets and inventory samples up to large scrap containers and fuel elements. It is concluded that, since no single assay technique is optimum for the wide variety of problems in fissionable material assay, it is necessary to have a working knowledge of the various assay methods for the optimum selection and application of the methods and instrumentation which best fulfill the needs of the different nuclear facilities. It is essential that instrumentation for in-plant application be as simple and reliable as possible. (L.C.L.)

32177 (CONF-700541–, pp 349-62) SUB-MeV NEUTRON ASSAY SYSTEMS FOR NUCLEAR MATERIALS. Gozani, T. (Gulf General Atomic, Inc., San Diego, Calif.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

Some of the basic principles, applications, and limitations of nondestructive assay system based on sub-MeV isotopic sources are discussed. The performance of one system is shown. This system which is based on low sub-MeV neutrons from an antimony–beryllium source is sensitive only to presence of fissile material and is very suitable to the assay of fuel elements with a highly probable future application to spent fuel elements. A second system which is briefly discussed is based on unmoderated/moderated high energy neutron source and is sensitive, but to a different extent, to both fissile and fertile materials. (auth)

32178 (CONF-700541–, pp 363-8) MEASUREMENT RELIABILITY OF DESTRUCTIVE AND NONDESTRUCTIVE TECHNIQUES OF ASSAYING A REACTOR FUEL INVENTORY. Perry, R. B.; Beyer, N. S.; Brandenburg, R. W. (Argonne National Lab., Ill.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

A plutonium reactor fuel inventory can be verified as reliably by gamma ray measurements as by conventional chemical-mass spectrometric techniques. A recent evaluation of the comparative reliability of assay of plutonium reactor fuel by destructive (chemical-mass spectrometry) or nondestructive (gamma ray spectrometry) techniques indicated that the measurement uncertainties associated with each case were nearly equivalent. This evaluation resulted from a numerical analysis of measurements made of 725 Pu-alloyed metal fuel plates. Every plate was assayed for ^{239}Pu and ^{241}Pu by the gamma ray spectrometry technique and 189 chemical-mass spectrometry analyses were made of the material from which the plates were fabricated. These two sets of measurements were used to determine the total quantity of material. The totals differed from each other by only three parts in 25,000 and the measurement error was established as about two parts in 1,770 for each case. This close agreement was possible despite the fact that the uncertainty of a single chemical-mass spectrometry measurement was ±1.8% as compared to ±3.0% for a single plate mea-

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surement by the gamma ray technique. Errors associated with weighing, sampling, and material heterogeneity affect the reliability of the measurement of a total inventory and the choice of analytical technique used to establish the total amount of material should be carefully made. A technique which has high precision and accuracy for a single measurement may not be the preferred method when the total amount of material in a reactor fuel inventory must be established. A discussion of the reliability of assay techniques is presented with illustrative examples. (auth)

32179 (CONF-700541–, pp 369-80) LOS ALAMOS MOBILE NONDESTRUCTIVE ASSAY LABORATORY (MONAL). Menzel, J. H.; Dennis, B. R.; Thorpe, M. M.; Walton, R. B.; Smith, D. B.; Keepin, G. R. (Los Alamos Scientific Lab., N. Mex.).

From eleventh annual meeting of the Institute of Nuclear Materials Management; Gatlinburg, Tenn. (25 May 1970).

In Institute of Nuclear Materials Management eleventh annual meeting.

The Mobile Nondestructive Assay Laboratory (MONAL), developed by the Los Alamos Scientific Laboratory to test and improve new assay techniques for the nuclear industry is described in detail. Information is presented on: the housing design; materials handling devices; detectors used; control and data acquisition systems; shielding; and active and passive assaying equipment. The performance of the MONAL at the Pu facility at Rocky Flats is related. These experiments included determination of the Pu content in Pu scrap by neutron interrogation and the measurement of ^{240}Pu content in various Pu-oxide-containing matrices using a neutron coincidence counter. Results on samples of homogeneous matrices were within 3% of the known ^{240}Pu content in these samples. (L.C.L.)

32180 (GEAP–12114-4) INTEGRATED SAFEGUARDS EXPERIMENT. Second Quarterly Report, September–November 1970. Wadekamper, D. C.; Hagie, L. T. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jan 1971. Contract AT(30-1)-68. 26p. (BHO–68-4). Dep. NTIS.

The first Integrated Safeguards Experiment, ISE Campaign 1, was completed and the second experiment, ISE Campaign 2, was initiated. Material balance calculations for two historical campaigns were completed. The plutonia feed measurements for two historical campaigns as well as ISE Campaigns 1 and 2 were reviewed and analyzed. Trial material balances and total oxide balances for ISE Campaign 1 were completed. Available ISE Campaigns 1 and 2 measurement and processing data applicable to material balance accounting are summarized. A brief explanation of the present Mechanized Accountability and Criticality System is presented. (auth)

32181 (JUL–710-DE) IMPROVEMENTS IN THE MANAGEMENT OF INTERMEDIATE LEVEL RADIOACTIVE LIQUID AND SOLID WASTE AT KFA, JUELICH. Rattay, Karl Heinz; Mallek, Heinz (Kernforschungsanlage, Juelich (West Germany). Abt. Dekontamination). Nov 1970. 12p. Dep. NTIS (U. S. Sales Only).

At Juelich solid and liquid wastes are mainly the result of scientific activities and of the operations of research reactors. The construction of an all-around shielded special cell (tunnel cell) was a substantial relief to avoid an excess of diffuse radiation. This cell enabled the safe storage of 28 pieces of 200-litre-drums, which rested on a slightly slanted slide-way to the outlet. The installation will remarkably improve the technical utilization of the storage building for intermediate-level radioactive waste. It was also necessary to construct additional equipment for the removal of intermediate-level radioactive liquid waste, since the installations used to treat these liquids do not have sufficient radiation shielding. This was the main reason for the development of a shielded pot drier. During the experiments it was found that the technical difficulties arise from large encrustations and contamination of the off-gas system. The use of an efficient filter only leads to better results. This filter is a main part of the pot. It will be removed and discharged together with the pot. (auth)

32182 (ORNL–4555) PROJECT SALT VAULT: A DEMONSTRATION OF THE DISPOSAL OF HIGH-ACTIVITY SOLIDIFIED WASTES IN UNDERGROUND SALT MINES. Bradshaw, R. L.; McClain, W. C. (eds.) (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 360p. Dep. NTIS.

Fourteen sections on the Project Salt Vault experiment for evaluating the feasibility of storing high-level solid radioactive wastes in salt deposits are included. A separate abstract was prepared for each paper. (L.C.L.)

For abstracts of individual sections see: 32183–32196.

32183 (ORNL–4555, pp 1-2) INTRODUCTION. Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The historical development of the concept of using natural salt formations in the US as repositories for high-level radioactive wastes is reviewed. (L.C.L.)

32184 (ORNL–4555, pp 3-12) SUMMARY OF PREVIOUS PERTINENT STUDIES. Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

Previous studies pertinent to the disposal of high-level radioactive waste in salt deposits are reviewed and include: measurement of the heat transfer properties of salt; the effects of temperature on the fracture of salt due to release of moisture trapped in the salt; radiation effects on the structural properties of rock salt; the gamma shielding properties of rock salt; mine stability studies; and the economics of solids disposal in salt. The following major conclusions were drawn from these studies: in situ heat transfer properties of rock salt are sufficiently close to the values determined in the laboratory that confidence can be placed in theoretical heat transfer calculations; most bedded salt contains trapped moisture which is released at temperatures above about 250°C; radiation exposure doses of 5×10^9 R produce some change in structural properties, but the effect on mine stability should be negligible; rock salt is approximately equivalent to concrete as a gamma radiation shield; stability of a waste disposal mine at ambient temperature can be predicted from observed conditions in existing salt mines; elevated temperatures will cause accelerated creep, but the exact effects on structural stability could not yet be predicted accurately; and preliminary estimates of the cost of a large-scale disposal operation in salt [about 0.01 mill/kWhr(e)] show that such an operation is economically compatible with competitive nuclear power. (L.C.L.)

32185 (ORNL–4555, pp 13-23) PRELIMINARY DESIGN OF EXPERIMENT. Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

Project Salt Vault was part of the development program designed to determine the requirements for the safe and economical disposal of radioactive wastes in rock salt formations. A demonstration experiment for obtaining salt flow data is described. Information is presented on: the selection of the mine and radiation source; calculation of fuel assembly temperatures; radiation dose calculations; the experimental layout in the mine; and method and equipment to be used for measuring the salt temperature patterns in arrays. The results obtained from this experiment should provide the technical basis for the design of an actual disposal facility. (L.C.L.)

32186 (ORNL–4555, pp 24-48) FIELD AND LABORATORY STUDIES PRELIMINARY TO PROJECT SALT VAULT. Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

A series of field and laboratory studies which preceded and are pertinent to Project Salt Vault are described. These included experiments on: plastic flow or creep characteristics of salt at elevated temperatures; the deformation of prototype hole lines at high temperature; corrosion of stainless steel waste containers; radiolytic Cl production; and the development of dosimeters for measuring the gamma dose delivered to the salt surrounding radioactive material. (L.C.L.)

32187 (ORNL–4555, pp 49-58) GEOLOGY AND DESCRIPTION OF THE LYONS MINE. Lomenick, T. F.; Empson, F. M. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The geology, history, and general description of the Lyons Mine in a Kansas salt deposit are discussed. This is the site selected for the Project Salt Vault demonstration experiment. (L.C.L.)

32188 (ORNL–4555, pp 59-66) MINE RENOVATION AND PREPARATION OF EXPERIMENTAL AREA. Empson, F. M.; McClain, W. C. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

A description and schedule of the mine renovation and preparation work performed at the Lyons salt mine prior to the installation of equipment directly connected with the Project Salt Vault

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experiments are presented. These preparations included: renovation or installation of mine hoist system, electrical system, and waste charging shaft; removal of mining machinery; cleanup, excavation, and preparation of waste disposal areas; and drilling of small diameter holes for experiment instrumentation and large diameter holes for waste shaft and waste emplacement. (L.C.L.)

32189 (ORNL–4555, pp 67-91) DESIGN AND FABRICATION OF EQUIPMENT. Boegly, W. J. Jr.; Schaffer, W. F.; Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The design and fabrication of special equipment required by major operations in Project Salt Vault are discussed. The equipment includes: casks for the safe containment and cross-country shipment of the radioactive materials; waste charging facilities at the mine entrance; machinery for the underground transfer of radioactive materials; facilities for storage in salt and the post-experiment removal of the radioactive materials; heaters and instrumentation for the heated-pillar experiment; auxiliary equipment such as heaters, power supplies, and off-gas systems; and instrumentation such as thermocouples, radiation detectors, alarm system, dosimeters, etc. Two appendixes are included and describe the shielding calculations and details of the Project Salt Vault remote alarm system. (L.C.L.)

32190 (ORNL–4555, pp 92-8) INSTALLATION OF EXPERIMENTAL EQUIPMENT. Empson, F. M.; McClain, W. C. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The installation of experimental equipment for Project Salt Vault is described. The equipment installed included: the waste charging facilities at the mine entrance; machinery for the underground transfer of radioactive materials; power distribution system; array hole liners; pillar heaters; and instrumentation for the power control and off-gas systems, for temperature measurements, and for radiation detection. Procedures used for checking out the installed equipment are discussed. This phase of the Salt Vault Project was accomplished in about six months, and brought preparations for the experiment to completion. (L.C.L.)

32191 (ORNL–4555, pp 99-123) HAZARDS ANALYSIS. Boegly, W. J. Jr.; Schaffer, W. F. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

A hazards analysis of Project Salt Vault equipment and procedures is described. Irradiated fuel elements from the ETR were selected for use as the radioactive material in the experiment rather than actual calcined wastes. The heat and total fission product activity of each fuel canister were calculated. The shipping casks were evaluated for structural integrity under accident and fire conditions and for their shielding, criticality, and heat removal capacities. Methods for handling and transport of the casks to and within the salt mine were analyzed for safety. Accidents which could release radioactivity from the fuel assembly canisters were studied and the possible radiation effects of such accidents calculated. On the basis of this safety analysis, the ORNL Radiochemical Plants Committee recommended approval of the Salt Vault experiment. (L.C.L.)

32192 (ORNL–4555, pp 124-60) OPERATING EXPERIENCE. Empson, F. M.; Houser, B. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The operational phase of the Project Salt Vault experiment occurred from Nov. 1965 to Feb. 1968. The pre-startup, startup, routine and nonroutine, cooldown, and closeout operations are discussed. The results of this demonstration related principally to the performance of and experience with equipment for handling the fuel element canisters. A second important investigation involved the operation of equipment for the pillar-heater experiment. No major difficulties were encountered, and the operational phase was successfully completed. (L.C.L.)

32193 (ORNL–4555, pp 161-256) RESULTS AND ANALYSIS. Bradshaw, R. L.; McClain, W. C. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The results of the experimental aspects of Project Salt Vault are presented in detail and analyzed. The broad categories studied were: radiation problems; moisture problems; temperature effects and heat transfer; and rock deformation and mine stability. (L.C.L.)

32194 (ORNL–4555, pp 257-90) LABORATORY PILLAR MODEL EXPERIMENTS. Lomenick, T. F. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The effect of temperature, compressive stress, and time on the deformation of rock salt was investigated through scale-model specimens of mine pillars. Tests were performed on samples of bedded salt, as well as on dome salt, from six different mines in the United States and from the anticlinal structure of the Asse II salt mine in northeast Germany. Efforts were made to ascertain the optimum model size for laboratory studies and to determine the effect of pillar shape on deformation. Finally, the effect of stratigraphic discontinuities on the deformational behavior of pillars and the mechanisms of pillar deformation were investigated. It was determined that a $5^{11}/_{16}$-in.-diam core of rock salt 5 in. long and ground out in the center to form a 4-in.-diam, 1-in.-high pillar adequately simulates mine conditions where pillar width-to-height ratios are about 4. Laboratory tests of samples from the Lyons mine were conducted at temperatures of 22.5, 60, 100, and 200°C for axial loads of 2000, 4000, 6000, 8000, and 10,000 psi at each temperature. From these tests it was concluded that deformation of the pillars increases markedly with increasing loads. However, even more significant is the greatly accelerated creep rate of the salt at elevated temperatures. At all axial loads and constant temperatures, there is initially a high creep rate that decreases with time. Creep rates are observed to continue to decline even after more than 3 years of testing. Model tests, verified by measurements in salt mines, show that thin shale beds, which commonly occur with bedded salt deposits, cause greatly accelerated rates of deformation in excavated cavities when they occur in the pillars at roof and floor interfaces. Under these conditions the shales, which are effective friction reducers, serve to reduce significantly the transfer of lateral confining stresses from the roof and floor of the openings into the pillars. Thus the pillars deform more nearly as if they were squeezed between two rigid plates and not as pillars without shale partings, where cavity closure is due to the lateral flowage of salt from the pillars into the openings as well as the more or less vertical movement of salt into the cavity from the roof and floor. (L.C.L.)

32195 (ORNL–4555, pp 291-316) ANALYSIS OF COMBINED EFFECTS. McClain, W. C.; Starfield, A. M. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The creep and stress in the entire experimental area for Project Salt Vault, i.e., the room-and-pillar salt mine with heat sources in the footwall, were studied. The combined influence of stress, stress history, heat, thermal gradients, and time were investigated experimentally and theoretically. Results of computer model calculations of creep, strain, and stress were compared with measured data. It was concluded that the underground rock deformation measurements and analysis program resulted in sufficient understanding of the effects of stress, elevated temperature, temperature gradients, and time on the deformation of salt to permit undertaking a rational design of an actual waste disposal facility in a salt deposit. (L.C.L.)

32196 (ORNL–4555, pp 317-56) SUMMARY AND CONCLUSIONS. McClain, W. C.; Bradshaw, R. L. (Oak Ridge National Lab., Tenn.).

In Project Salt Vault: a demonstration of the disposal of high-activity solidified wastes in underground salt mines.

The ten year ORNL research and development program aimed at establishing the feasibility, safety, and techniques for disposing of high-level radioactive power reactor wastes in natural salt formations is summarized. The background, early studies, design, installation, and operation of Project Salt Vault, and conclusions derived from this project are documented in as complete detail as possible. It was concluded that Project Salt Vault successfully demonstrated: the feasibility and safety of handling highly radioactive materials in an underground environment; the stability of salt under the effects of heat and radiation; the capability of solving minor structural problems by standard mining methods; and that data obtained on the deformation characteristics of salt made it possible to design a suitable mine disposal facility. A separate preliminary economic analysis indicated that the costs of power reactor waste solidification and disposal in salt deposits were completely compatible with competitive nuclear power and that such disposal facilities will be needed for the anticipated rapid expansion of commercial nuclear power plants. (L.C.L.)

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32197 TRANSFER DEVICE. Aujard, Michel; Morin, Henri (to Commissariat a l'Energie Atomique). French Patent 2,032,221. 9 Nov 1970. Filed 21 Feb 1969. (In French).

A device has been developed to transfer an object, particularly an irradiated sample kept at low temperature, from a sampling post to a storage post some distance away. It includes a guide rail passing over both posts and sloping from the sampling post towards the storage post, a mobile container mounted on the guide rail and free to move along it by gravity in the direction of the slope, a remotely controlled electric motor governing the rotation of the drum, and means of stopping and locking the container on the guide rail, vertically above the sampling and storage posts. (France)

32198 GRAPNEL FOR HANDLING MATERIALS. Meynier, Paul (to Electricite de France). French Patent 1,592,351. 11 May 1970. Filed 19 Nov 1968. (In French).

A grapnel is described in which the gripping claws are hinged to a body connected to the maneuvering parts. The grapnel consists of a mobile piston moving in a cylinder, axial to the body, and two shafts, hinged about the stem of the piston and one of the claws. A means is provided to control the movement of the piston in the cylinder so that the claws may be pivoted between the grabbing and charge release positions. (France)

32199 SAMPLE HANDLING DEVICE FOR MICROSCOPE IN A HOT CELL. Brachet, Paul (to Commissariat a l'Energie Atomique). French Patent 1,602,189. 19 Oct 1970. Filed 31 Dec 1968. (In French).

The invention concerns a remotely controlled sample-handling device for a microscope placed in a hot cell and equipped with a receiving post for delivery or removal of the samples by a transport system. The device includes a horizontal arm fitted at one end with sample-gripping tongs and held at the other end by a shaft parallel to the optical axis, placed on the periphery of the microscope stage and equipped with means of vertical movement with respect to the microscope stage and movements of rotation around the axis of the shaft. (France)

32200 TREATMENT AND STORAGE OF RADIOACTIVE WASTES. PART 1. SOURCES AND CLASSIFICATION OF RADIOACTIVE WASTES. Schlosser, K. (Oesterreichische Studiengesellschaft fuer Atomenergie GmbH, Seibersdorf, Austria). Elektrotech. Maschinenbau; 87: 378-83(Aug 1970). (In German).

A survey of radioactive wastes from nuclear reactors and users of isotopes (hospitals, research centers, etc.) is presented. The most important methods of treating and storing of wastes are described. An estimate of the wastes to be expected from a typical 600 MW(e) pressurized water reactor nuclear power plant with boric acid control is presented. The criteria for the selection of a storage location are discussed. The most suitable methods for the Austrian situation are shown. (auth) (INIS)

32201 AMERICAN NATIONAL STANDARD: RADIATION SYMBOL. ANSI N 2.1 1969. New York; American National Standards Institute, Inc. (1970). 4p. Available from American National Standards Inst., New York.

This standard designates a radiation symbol which shall be used to signify the actual or potential presence of ionizing radiation and to identify objects, devices, materials, or combinations of materials which emit ionizing radiation. This standard does not specify the radiation levels at which the symbol is to be used. (L.C.L.)

32202 AMERICAN STANDARD: GUIDE TO PRACTICE IN TRANSPORTATION OF SOURCE AND SPECIAL NUCLEAR MATERIAL BEFORE IRRADIATION. ANSI N 5.1 1962. New York; American Institute of Chemical Engineers (1962). 8p. Available from American National Standards Inst., New York.

A standard is presented which provides useful information concerning the pre-irradiation transportation of source and special nuclear material to all persons engaged in such activity, including shippers, receivers, and carriers. (L.C.L.)

32203 AMERICAN STANDARD: SAFETY STANDARD FOR OPERATIONS WITH FISSIONABLE MATERIALS OUTSIDE REACTORS. ANSI N 6.1 1964. New York; American Society of Mechanical Engineers (1964). 3p. Available from American National Standards Inst., New York.

This standard provides guidance in the prevention of nuclear chain reactions in all procedures outside reactors for handling, storing, processing, transporting, and treating fissionable nuclides. Generalized basic criteria are presented to achieve this purpose. Solutions to specific problems may be derived from the referenced literature. (L.C.L.)

32204 AMERICAN NATIONAL STANDARD: NUCLEAR CRITICALITY SAFETY IN OPERATIONS WITH FISSIONABLE MATERIALS OUTSIDE REACTORS. ANSI N 16.1 1969. Hinsdale, Ill.; American Nuclear Society (1970). 7p. Available from American Nuclear Society, Hinsdale, Ill.

This standard is applicable to operations with ^{239}Pu, ^{233}U, and ^{235}U, and other fissionable materials outside of nuclear reactors except the assembly of these materials under controlled conditions, such as in critical experiments. Generalized basic criteria are presented and limits are specified for some simple single fissionable units but not for multiunit arrays. This standard does not include the details of administrative controls, the design of processes or equipment, the description of instrumentation for process control, or detailed criteria to be met in transporting fissionable materials. (L.C.L.)

32205 TRANSPORTATION OF RADIOACTIVE MATERIALS. Blackburn, R. W. Ottawa; Canadian Atomic Energy Control Board (1967). 45p. Available from Canadian Atomic Energy Control Board, Ottawa.

Radioactive materials transport regulations which are internationally uniform for all modes of transport are being adopted by most countries including Canada. The bases for these regulations and their applications in Canada are discussed. (L.C.L.)

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INSTRUMENTATION

Radiation Detection Instruments

General Detectors and Monitors

Refer also to abstracts 32057, 32371, 32469, 32481, 32488, 32563, 32591, 33923, 34409, and 34410.

32206 (AAEC/TM-584) OPERATION NEAR LIQUID HELIUM TEMPERATURE OF A GOLD-BARRIER HYPER-PURE GERMANIUM DETECTOR FOR GAMMA RAYS. Lawson, E. M.; Tavendale, A. J. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Feb 1971. 17p. Dep. NTIS (U. S. Sales Only).

Diode characteristics and spectral response to ^{137}Cs γ-rays of a gold-barrier detector made from hyper-pure germanium (net donor concentration 3×10^{11} cm^{-3}) were examined over the temperature range 5 to 78°K. Trapping at the primary shallow donor is believed responsible for poor energy resolution at low temperatures. At 5°K a best resolution of 10 keV FWHM was obtained. Efficiency measurements indicate no change in depletion depth on cooling to 5°K with constant bias, in contrast to capacitance measurements. The latter variation, however, can be explained in terms of the response of the detector equivalent circuit to bridge frequency and carrier freeze-out effects. Field-assisted detrapping at the primary shallow donors is believed responsible for the temperature independent depletion depth and an improvement in resolution with bias in the low temperature carrier freeze-out region (<10°K). (auth)

32207 (AERE-R-6732) PENA-DETECTOR FLUX-MEASURING SYSTEM WITH A FAST RESPONSE. Johnstone, W. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 19p. Dep. NTIS (U. S. Sales Only). UK 17p.

Primary-emission neutron-activated (PENA) detectors are simple in construction, robust, capable of working at high temperatures, and do not require polarizing supplies. They have certain disadvantages, but these have now been overcome by introducing a compensating conductor and using a differential amplifier for current measurement by the availability of encapsulated F.E.T.-input amplifiers that have bias and drift currents several orders less than the lowest current likely to be measured, and by using an inverse-function amplifier to predict the final values of the slowly changing output of the current amplifier. The method employed to obtain the overall time constant of a complete system which is considerably shorter than the constituent parts is described. The method by which the resulting fast-response system was designed to accept a number of inputs, selected in turn, without saturating and "latching up", is given. (auth) (UK)

32208 (BNWL-1552) TECHNOLOGICAL CONSIDERATIONS IN EMERGENCY INSTRUMENTATION PREPAREDNESS, PHASE I. CURRENT CAPABILITIES SURVEY. Selby, J. M.; Unruh, C. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jan 1971. Contract AT(45-1)-1830. 83p. Dep. NTIS.

The radiological emergency instrumentation currently in place at a selected number of contractor and private nuclear facilities was reviewed. Some twelve power reactors, eleven AEC sites, four test reactors, three research reactors, two fuel reprocessing plants and one plutonium fuel fabrication plant were included in the survey. A wide variation was observed in the types and performance capabilities of the radiological emergency instrumentation currently installed. Radiological emergency instrumentation was found to be deficient to some degree at all facilities visited. Much of the instrumentation observed was designed and installed primarily for use in routine monitoring operations and hence was applicable only for the measurement of normally anticipated releases of radioactive materials. The deficiencies in emergency instrumentation were principally attributable to inadequately designed instrumentation, improper installation, inadequate calibrations or limited response ranges. It was concluded that all nuclear facilities need performance criteria for radiological emergency instrumentation to provide a sound basis to define the specific needs for and to evaluate the adequacy of such instrumentation. These emergency instrumentation performance criteria would also be of value in assessing a facility's overall instrumentation preparedness to meet radiological emergencies and would assist licensing groups in determining emergency instrumentation requirements and capabilities. (auth)

32209 (INP-737) AN UNIVERSAL, HIGH STABILITY RADIOIONIZING DETECTOR FOR GAS CHROMATOGRAPHY. Lasa, J. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 20p. (In Polish). Dep. NTIS (U. S. Sales Only).

The basic parameters characterizing the construction of a new detector, model DNW, are presented. This detector can be used as a cross section detector, model DNW-100, an argon detector, model DNW-200, or as an electron capture type detector, model DNW-300. Nickel-63 was used as the ionizing source in the detector. The detector can work at temperatures up to 400°. (auth)

32210 (INR-1240) STANDARDIZATION OF $\beta-\gamma$ EMITTERS BY $4\pi\beta-\gamma$ COINCIDENCE METHOD. Chylinski, A.; Radoszewski, T. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 28p. Dep. NTIS (U. S. Sales Only).

The theory of the $4\pi\beta-\gamma$ coincidence method is given with all corrections and counting errors. The counting equipment is described, and some investigations of the detectors to find the optimal conditions of counting are discussed. The described method has been checked by measurements of Co-60 solutions which were distributed by Bureau International Des Poids Et Mesures for intercomparison. The $4\pi\beta-\gamma$ coincidence method has been applied also for standardization of following nuclides: I-131, Zr-95, Co-144 + Pr-144, Sb-125, Sc-46, Nb-95, Eu-152, Eu-155, Na-22, Cs-134. (auth)

32211 (INR-1274) APPLICATION OF SEMICONDUCTOR DETECTORS FOR X-RAY FLUORESCENT ANALYSIS. Chwaszczewska, J.; Dybowski, K.; Sawicka, B.; Tys, J. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 14p. (In Polish). Dep. NTIS (U. S. Sales Only).

A possibility of quantitative fluorescent analysis of metal and salt samples was tested using a Si(Li) spectrometer. The characteristic x-rays of measured samples were excited by 1 mCi-^{241}Am or 3 mCi-^{109}Cd γ rays and by H^+ and Xe^+ ions accelerated up to 100 to 200 keV by the GN-200 accelerator. The energy resolution of the Si(Li) spectrometer was 1 keV for a 6 keV γ ray. The lower limit of the spectrometer sensitivity was about 4 keV. (auth)

32212 (JINR-P13-5689) UNIVERSAL PULSE SHAPER FEU. Rykalin, V. I.; Tsisek, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 19p. (In Russian). Dep. NTIS (U. S. Sales Only).

A double-channel pulse shaper FEU is described. The operation threshold of the shaper is 100 mV. Output pulse duration is varied within 10 to 100 nsec. Speed of response of the shaper is 100 MHz. One channel of the shaper has no dead time. (auth)

32213 (JINR-P13-5742) INTEGRATOR OF NANOSECOND SIGNALS WITH CONTROL. Budyashov, Yu. G.; Zinov, V. G.; Krasnoborodov, B. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

A scheme is described which is designed for the linear gating of nanosecond signals with their simultaneous extension to the duration providing the normal operation of a multichannel analyzer. The value of the base from the controlling signal is regulated as desired and can be both of positive and negative sign. (auth)

32214 (KFK-1182) MONTE-CARLO METHOD FOR EVALUATION OF THE EFFICIENCY OF A BORON-NaI COUNTER. Brandl, Volker (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronphysik und Reaktortechnik). Dec 1970. 33p. (In German). Dep. NTIS (U. S. Sales Only).

A Monte-Carlo code for the evaluation of the efficiency of a B-NaI neutron counter is described. The counter detects the 478 keV gammas from the sequence of reactions: $^{10}B + n = {}^{7m}Li + \alpha + 2.3$ MeV; $^{7m}Li \rightarrow {}^{7}Li + \gamma + 478$ keV. Multiple elastic scattering of the neutrons on ^{10}B and $(CH_2)_n$ is taken exactly into account by the code. For an arbitrary energy group of the neutrons the detector efficiency is, in principle, evaluated by an analog Monte-Carlo method. In all other energy groups the efficiency is simultaneously computed by the sampling of corresponding weights. The most important input data of the code are the geometry of the counter and the nuclear cross sections of its constituents. (auth)

32215 (LA-4568) TOTAL ABSORPTION IONIZATION CHAMBER FOR 1.5-10 keV X-RAYS. Lyons, P. B.; Baran, J. A.; McCrary, J. H. (Los Alamos Scientific Lab., N. Mex.). Dec 1970. Contract W-7405-eng-36. 14p. Dep. NTIS.

The design of a xenon gas ionization chamber is presented. Corrections to energy fluence measurements are considered. The correction for escape of xenon fluorescent L x rays was

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measured with a xenon–methane proportional counter. The chamber was compared to a Si(Li) detector and an argon–methane proportional counter over the energy range from 1.7 to 10.5 keV. The chamber was shown to be accurate to ±2%, independent of uncertainties in entrance window transmission. Overall chamber accuracy is ±3%. The useful energy fluence rate range for the chamber was shown to be from below 10^{-11} to 5×10^{-5} W/cm^2. A value of 21.5 ± 0.4 eV for the mean energy per ion pair in xenon was obtained from the measurements. A chamber useful up to 35 keV could be constructed without accuracy degradation by an increase in chamber size. (auth)

32216 (UCRL-20135) PARTICLE DETECTORS BASED ON NOBLE LIQUIDS. Muller, Richard A.; Derenzo, Stephen E.; Smits, Robert G.; Zaklad, Haim; Alvarez, Luis W. (California Univ., Berkeley. Lawrence Radiation Lab.). Sep 1970. Contract W-7405-eng-48. 8p. (CONF-700902-7). Dep. NTIS.

From International conference on instrumentation for high energy physics; Dubna, USSR (8 Sep 1970).

In order to build a thin particle detector with 10 micron spatial resolution and automatic readout, the avalanche of ionization electrons in high electric fields in liquid argon and liquid xenon has been studied. A scheme using an array of points that could be used to make a reliable liquid argon filled detector is presented. The avalanche pulses in liquid xenon have a rise time more than three orders of magnitude faster than that in liquid argon, suggesting that the positive charge carriers are holes, and making possible a detector with a time resolution of better than 100 nanoseconds. A direct observation of hole conduction is described. (auth)

32217 IMPROVEMENTS IN OR RELATING TO LIQUID SCINTILLATION COUNTING AND COMPOSITIONS. Sena, Edwin Andres. British Patent 1,222,111. 10 Feb 1971. Priority date 1 Feb 1967, United States.

A process for preparing thermodynamically stable, liquid scintillation counting compositions for counting radioactive samples is described. The thermodynamically stable scintillation counting cocktails comprise surfactant scintillators, scintillation solvent, and radioactive sample, the cocktail exhibiting essentially no chemiluminescence or phosphorescence during counting. (R.W.R.)

32218 PARTICLE DOSIMETER FOR MEASURING DOSES OF PARTICLES SUCH AS NEUTRONS. (to Institutet for Halvledarforskning). British Patent 1,225,637. 17 Mar 1971. Priority date 29 May 1967, Sweden.

The design of a p–i–n semiconductor diode detector is described. (W.H.K.)

32219 CRITICALITY DETECTOR (21 Dec 1970) (Engineering Materials). (Richland Operations Office (AEC), Wash.). (CAPE-2075).

5 drawings.

An improved alarm system, which detects and warns against uncontrolled neutron criticality events, is described. This system is neutron sensitive with an alarm threshold of 8 mrad/hr of "steady" irradiation or 4 μrad of pulsed radiation. Operation reliability is enhanced by redundancy techniques and self-check features. An annunciator panel and comparator unit accommodate up to 12 detector units to monitor an entire building. The comparator unit checks the condition of the detectors and building wiring with a half-wave circuit. Alarm is arranged on a "two out of n" basis. The unit is highly resistant to external radiation and electrical interferences and disturbances. The neutron sensitive element is a BF_3 tube enclosed in a polyethylene moderator. Sensitivity of the tube is ~6000 cpm at 1 mrad/hr. (For details see TID-4100 Suppl. 63) (see also 25: 6532) (F.S.)

32220 COMPARATIVE CHARACTERISTICS OF COMPOSITE AND DISPERSED AIR-EQUIVALENT SCINTILLATORS. Arsaev, M. I.; Krasnikov, V. A.; Margulis, B. G. At. Energ. (USSR): 30: 64-6(Jan 1971). (In Russian).

Air-equivalent scintillators are made by introducing into the scintillator a compensating substance having an effective atomic number greater than that of air. In the dispersed type the compensator is introduced as a metal-organic chemical compound that can form a solution with the primary scintillator or may be dispersed in the form of fine particles. These scintillators are isotropic, and are homogeneous in composition and properties. The composite scintillator has a theoretical advantage over the dispersed type of scintillator because of a lesser dependence of the sensitivity on the energy of the radiation. The gamma radiation is first absorbed in the material with a high Z (compensating material) with further absorption in the body of the scintillator. Composite scintillators also show better sensitivity because the compensating material is not introduced into the body of the main scintillator with a resulting loss in transparency. Experimental work with a scintillating polystyrene as a base material and a ZnS(Ag) luminophore as the compensating material on top confirmed the above conclusions. The change in sensitivity for energies above 30 keV is practically the same for both types of scintillators. However, for energies below 30 keV the change in sensitivity of the composite scintillator is substantially smaller than that of the dispersed scintillator. (TTT)

32221 INTEGRATED CIRCUIT MULTI-CELL P–N JUNCTION RADIATION DETECTORS WITH DIODES TO REDUCE CAPACITANCE OF NETWORKS. Koehler, Dale R. (to Bulova Watch Co., Inc.). U. S. Patent 3,564,245. 16 Feb 1971. Filed 24 Jan 1968.

A multicellular, solid-state radiation detector assembly, adapted to produce exceptionally large signals in response to incident radiation is described. The detector is constituted by an array of individual surface-barrier or diffused-junction radiation-sensitive, semiconductive cells, each of which has a small area and a low internal capacitance. The cells in the array are unidirectionally connected in parallel with respect to current flow, but are otherwise electrically isolated from each other. As a result, the overall capacitance of the array is low while the detection efficiency thereof is substantially equal to a unitary radiation detector whose surface area is equivalent to the aggregate area of the cells; the signal output from the multicellular detector is far greater than that yielded by the unitary detector. (auth)

32222 GAMMA DOSIMETRY USING A SPP_3 SCINTILLOMETER. Buxerolle, M.; Elias, J. C.; Gigodeaux, R.; Ponce, R. (CEA, Cadarache, France). Radioprotection; 6: No. 1, 1-21 (1971). (In French).

The use and calibration of a highly sensitive portable protection scintillometer, the SPP_3, is described. The data are treated by computer. The calculation of a dose rate absorbed in the range between a few $\mu rad \cdot h^{-1}$ and about 1 $mrad \cdot h^{-1}$ for photons between 50 keV and 2 MeV is obtained with an error of less than 20 percent and gives information on the spectral distribution. (auth)

32223 OBTAINING THE POSSIBLE MAXIMUM OF 90 PERCENT EFFICIENCY FOR COUNTING OF ^{55}Fe IN LIQUID SCINTILLATOR SOLUTIONS. Horrocks, Donald L. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop.; 22: No. 4, 258-60(Apr 1971).

The confusion in the literature on the counting of ^{55}Fe in liquid scintillation counters is discussed. This confusion arises from misunderstanding of the process of electron capture leading to an incorrect figure of 26% for the maximum counting efficiency of the 5.9 keV K x-rays of Mn being quoted. Although true for measurement of ^{55}Fe in solid form this is incorrect for samples dissolved in a liquid scintillator solution. Using a scintillator solution of ^{55}Fe as the complex of di-(2-ethyl-hexyl) phosphoric acid the counting efficiency should be nearly 90% depending on the low energy bias and the rate of x ray escape from the scintillator solution. (UK)

32224 NITRILES AS SCINTILLATION SOLVENTS: BENZO- AND ACETONITRILE. Gomez, Elsa; Freer, Juanita; Castrillon, Jose (Puerto Rico Nuclear Center, Univ. of Puerto Rico). Contract AT(40-1)-1833. Int. J. Appl. Radiat. Isotop.; 22: No. 4, 243-50(Apr 1971).

Benzonitrile is shown to be an efficient scintillation solvent. Although somewhat inferior to toluene, it can surpass the performance of this standard solvent if quenchers are present. Furthermore, its high dielectric constant, dipole moment and complexing ability make it suitable for the counting of polar and metallic compounds. It has the interesting property of showing an appreciable light yield in the pure state, thus allowing the counting of α-emitters with no fluors added. Acetonitrile, on the other hand, is a very poor scintillation solvent, although it improves considerably on addition of naphthalene. Also, in a 40% mixture with benzonitrile, the efficiency is good enough for most purposes. (auth) (UK)

32225 EFFECTS OF SOURCE-ABSORBER SPACING IN THE $4\pi\beta-\gamma$ COINCIDENCE COUNTING OF ^{106}Ru–^{106}Rh. Kawada, Y.; Kimura, M. (Electrotechnical Lab., Tokyo). Int. J. Appl. Radiat. Isotop.; 22: No. 4, 251-3(Apr 1971).

The $4\pi\beta-\gamma$ coincidence method of standardization of ^{106}Ru–^{106}Rh and the corrections to be applied are discussed. In order to investigate the effect on the coincidence absorption method of correction when the effective geometrical efficiency is reduced below unity by appreciable spacing between source and absorber, the method was used on a sandwiched ^{106}Ru–^{106}Rh source with various conditions of spacing. (UK)

32226 THE WHOLE BODY COUNTER AT THE CASACCIA CENTER FOR NUCLEAR STUDIES. Clemente, Gianfelice (CNEN–CSN, Casaccia, Italy). Minerva Fisiconucl.; 12: 214-21(Jul-Sep 1968). (In Italian).

The design, operation, calibration, and performance of the Casaccia whole-body counter are described. The detector consists of a 20 × 10 cm NaI(Tl) scintillation detector that is viewed by three photomultipliers. The shielding design and the cell room facilities are described. Experimental data are presented and discussed. (W.H.K.)

32227 INTERMEDIATE-ENERGY NEUTRON DETECTOR. Fominykh, V. I.; Migun'kov, O. A. At. Energ. (USSR); 30: 59-60(Jan 1971). (In Russian).

The detector moderator was made of two plexiglas hemispheres 114 mm in diameter with a wall thickness of 12 mm in order to detect about 1 MeV neutrons in the presence of gamma radiation. Low sensitivity of the detector for gamma radiation was attained by using corona counters whose background was less than 2 counts per min in the presence of 2000 R/hr gamma radiation. An SbBe source was used to obtain 25 keV neutrons; a RaBe source for 300 keV neutrons, and a PoB source for 2.8 MeV neutrons. The counting sensitivities for the above neutron energies were 2.29×10^{-4}, 1.76×10^{-4} and zero counts per neutron respectively. The counting sensitivity for thermal neutrons was found to be 1.71×10^{-3} counts per neutron. Thus with this intermediate neutron detector it is impossible to determine a 2 MeV neutron flux above 7 neutrons/sec. cm^2 in gamma fields up to 2000 R/hr. (TTT)

32228 ABSOLUTE BOLOMETER DETECTOR FOR ENERGETIC NEUTRAL PARTICLES. van de Runstraat, C. A.; van Resandt, R. Wijnaendts; Los, J. (FOM-Inst. for Atomic and Molecular Physics, Amsterdam). J. Phys., E (London); 3: 575-8(Jul 1970).

A bolometer detector for atomic beams is described. It consists of a cage, whose shape ensures nearly complete dissipation of the beam power, and a thermistor attached to it. A convenient calibration procedure with ion beams is provided by simultaneous operation as thermal detector and as Faraday cup. The smallest detectable power is 10^{-8} W. Absolute currents of neutral particle beams with energies down to 100 eV have been measured. (auth) (UK)

32229 METHOD AND APPARATUS FOR COMPENSATING OF QUENCHING IN LIQUID SCINTILLATION COUNTING. Jordan, Pierre (to Picker Corp.). U. S. Patent 3,560,744. 2 Feb 1971. Priority date 26 Jun 1965, Switzerland.

A method and apparatus for automatically counting the activity induced in a test sample containing a radioactive isotope is described. The device compensates for the amount of quenching in the test sample by adjusting the photomultiplier excitation or the gain of the amplifier in the detection system. (auth)

32230 INSTRUMENT TO MEASURE ANISOTROPIES OF COSMIC-RAY ELECTRONS AND PROTONS FOR THE EXPLORER 34 SATELLITE. Bartley, W. C.; McCracken, K. G.; Rao, U. R.; (and others) (Univ. of Texas, Dallas). Solar Phys.; 17: 218-40(Mar 1971).

An instrument to measure the anisotropy and energy spectra of cosmic-ray electrons and protons, and x rays of solar and galactic origin is described. Such instruments were launched on May 24, 1967 and June 21, 1969 as component parts of the scientific payloads of the Explorer 34 and 41 satellites. A general description and the main characteristics of the detectors are presented and the stability of the instrument on Fxplorer 34 over its 23 months of operation is discussed. The method of analysis of the obtained angular distribution of solar cosmic-ray particles in the ecliptic plane is given. It is shown that the anisotropy of low-energy particles of solar origin decreases sharply to a very small value when the satellite penetrates the magnetosphere. (auth)

32231 VERSATILE PULSE AMPLIFIER. Lampton, M.; Primbsch, J. H. (Univ. of California, Berkeley). Rev. Sci. Instrum.; 42: 731-2(May 1971).

A pulse amplifier that can be used with scintillation counters, surface-barrier detectors, proportional counters, or channel electron multipliers is described. A circuit diagram is given. (W.H.K.)

32232 COMPARISON OF Ta, W, AND Pt–8 PERCENT W SURFACE IONIZATION DETECTORS FOR FAST POTASSIUM ATOM DETECTION. Cuderman, J. F. (Sandia Labs., Albuquerque, N. Mex.). Rev. Sci. Instrum.; 42: 583-6(May 1971).

Data are presented which describe and compare the behavior of Ta, W, and Pt– 8% W surface ionization detectors for fast potassium atom detection. The potassium atom energy in these experiments covered the range from thermal energy to 500 eV. (auth)

32233 WIDE BAND LOW NOISE VOLTAGE SENSITIVE PREAMPLIFIER WITH TEMPERATURE COMPENSATION. Kopp, M. K. (Oak Ridge National Lab., Tenn.). Rev. Sci. Instrum.; 42: 714-15(May 1971).

A direct coupled preamplifier for proportional counters is described. The preamplifier has high input impedance and good stability against changes in ambient temperature. A circuit diagram is given. (W.H.K.)

32234 ORGANIC SCINTILLATORS AND LIQUID SCINTILLATION COUNTING. Proceedings of the International Conference, San Francisco, July 7–10, 1970. Horrocks, Donald L.; Peng, Chin-tzu (eds.). New York; Academic Press, Inc. (1971). 1091p. $24.00. (CONF-700716).

The first section of the book includes the theory of solvent excitation and energy migration, the correlations between molecular conformation and fluorescence properties, the use of lasers to study fluorescence properties in the pico-second time period, excimers, and the role of oxygen in the quenching process and discusses the techniques of evaluation of different compositions of liquid scintillator solutions, and the use of these for measuring radioactivity in animals and humans and bioluminescence. The second section deals with the processes of photo-physics including studies of the effects of quenching and energy transfer, of the measurements of fluorescence yields (absolute and relative) and radiative lifetimes, and properties of excitons and their role in the fluorescence scheme. The final section deals primarily with the application of the fluorescence processes to the measurement of radioactivity and the use of liquid scintillation counting techniques in the study of chemically produced luminescence and Cherenkov counting. This volume will be of interest to radiation biologists, physicians, solid-state physicists, and chemists. (auth)

32235 RECENT PROGRESS IN COMPUTER PROCESSING OF X-RAY AND RADIOISOTOPE SCANNER IMAGES. Selzer, Robert H. (California Inst. of Tech., Pasadena). Biomed. Sci. Instrum.; 6: 225-34(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Over the past three years, research has been conducted at the Jet Propulsion Laboratory on the use of computers to enhance medical radiographs. Earlier film scanning and digitizing problems have been partially overcome so that it now appears possible to produce an enhanced image that is superior to the original film. Non-linear and adaptive filters show promise for reducing image noise more effectively than could be accomplished with linear filtering techniques. Enhancement techniques applied to the output from radioisotope scanners have produced images substantially superior to those obtainable with existing clinical displays. (auth)

32236 TAPE RECORDING AS AN ADJUNCT FOR SIMULTANEOUS MULTIRADIONUCLIDE IMAGING. Ben-Porath, Moshe (Loyola Univ., Hines, Ill.); Clayton, Glenn D.; Kaplan, Ervin. Biomed. Sci. Instrum.; 6: 235-40(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

The use of a 4-channel tape recording-display system is described for multi-isotope scanning. It has been shown that this technique (1) provides a superior display of the scanning information; (2) permits the analysis of the scan at various contrast settings; and (3) may aid in the visualization of brain lesions. It has been shown that ^{75}Se-methionine concentrates in the myocardium at a sufficient level to permit good visualization of this organ. (auth)

32237 U. M.–BENDIX SCINTILLATION CAMERA. Rogers, W. Leslie (Bendix Aerospace Systems Div., Ann Arbor, Mich.); Thomas, F. Deaver; Beierwattes, W. H.; Colvin, T. H. Biomed. Sci. Instrum.; 6: 248-55(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

The University of Michigan and Bendix have cooperated in the development of a scintillation camera of the crystal-lens-image intensifier configuration. The intensifier, an EMI type 9694 with a NaK bialkali photocathode, exhibits a noise rate of 12 electrons/cm^2-sec and about 2 ion spots over the entire tube face in 15 seconds. The luminous gain at 4300 Å is 10^6 which enables single photoelectron events to be photographed with Polaroid film. The inherent advantages of such a camera system are high resolution and high counting rate capabilities. The resolution exclusive of the collimator is better than 1 mm. The inherent disadvantages

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are low counting efficiency and the difficulty of incorporating pulse height discrimination. (auth)

32238 GAMMA RAY IMAGE CHARACTERISTICS IN SODIUM IODIDE SLABS. Knoll, Glenn F. (Univ. of Michigan, Ann Arbor). Biomed. Sci. Instrum.; 6: 256-61(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

A Monte Carlo calculation has been made of the effects of detector scattering on the gamma ray imaging properties of sodium iodide slabs. All interactions within the detector were assumed to contribute to the image. A detailed accounting was kept of the radial distribution away from the point of incidence of both the number of interactions and the deposited energy. Data are presented for slabs of thickness ranging from $\frac{1}{8}$ in. to 2 in., and over the energy interval from 140 keV to 999 keV. The results of these calculations show that with respect to multiple crystal interactions the major deterioration in image resolution with increasing energy occurs up to about 400 keV. Beyond this energy, most effects remain relatively constant and some actually tend toward improved resolution at higher energies. The improvement in interaction efficiency with crystal thickness is less pronounced when one considers events which contribute constructively to image formation rather than all events, and must be weighed against the severely increased multiple scattering evidenced by all the properties listed in this study. (auth)

32239 COMPUTER PROCESSING AND DISPLAY OF RADIOISOTOPE SCINTIGRAPHS. Wilensky, Samuel; Littleboy, Henry; Pizer, Stephen M.; Brownell, Gordon L.; Ashare, Alan B. (Massachusetts General Hospital, Boston). Biomed. Sci. Instrum.; 6: 262-5(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

A PDP-7 computer to process and display positron brain scintigraphs is discussed. The scintigram processing procedures include smoothing routines for reducing statistical fluctuation and enhancement routines to improve spatial resolution. The processed scintigrams are displayed on an oxcilloscope which has been interfaced to the computer via a hybrid (digital–analogue) processor which allows a 128 × 128 matrix to be displayed at up to 20 frames/sec. Each matrix element has 6 bits (64 levels) of intensity. The scope interface has provision for transforming the scintigram into a volumetric display, a display of isocount contours, or of X or Y profiles. (auth)

32240 IMAGE RESTORATION AND DISPLAY OF RADIOISOTOPE SCAN DATA. Wann, Donald F. (Washington Univ., St. Louis); Susman, Noah. Biomed. Sci. Instrum.; 6: 266-74 (1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Techniques for the restoration of the two dimensional spatial images produced by rectilinear radioisotope scanning are discussed. The scan data is quantized and recorded in a digital format. Using the point response of the collimator, the modulation transfer characteristic can be obtained thus providing a knowledge of the frequency distortion imposed on the original image. A suboptimal procedure can be utilized in order to generate a processing filter for the restoration of the attenuated high frequencies. Two methods of image restoration are discussed: spatial convolution and frequency domain filtering. It is shown that the latter requires less computer execution time. For example the restoration of a 32 × 32 image can be performed in approximately 30 seconds. Problems involved in the evaluation and display of the restored data are discussed. Numerous display formats are presented including gray level pictures, contouring, and stereo. Finally, a statistical test and corresponding display are described and experimental results presented. (auth)

32241 APPLICATION OF THREE-DIMENSIONAL DISPLAY TECHNIQUES TO RADIONUCLIDE IMAGING. Maynard, H. M.; Engler, P. E. (Cornell Aeronautical Lab., Inc., Buffalo). Biomed. Sci. Instrum.; 6: 275-83(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Methods of combining autofluoroscope data using orthogonal biplanar autofluoroscopes to produce a three-dimensional representation of the absorbed radioactive material are investigated with general purpose computer processes. The algorithms for implementing the transformation of multiple two-dimensional images to three-dimensional representations are implemented on an IBM 360/65 digital computer and the results are displayed on an online high-resolution flying-spot scanner. Details of methods developed are presented using actual data with illustrations of the results obtained. The study is evaluated in terms of effectiveness and applicability, and areas of future development are indicated. (auth)

32242 WHAT DO RECTILINEAR SCANNING DEVICES SEE. Mozley, James (Upstate Medical Ceneter, Syracuse, N. Y.). pp 151-64 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Use of the modulation transfer function for evaluating the performance of a radioisotope scanner is described. (W.H.K.)

32243 WHAT DO CAMERAS SEE. Gottschalk, Alexander (Univ. of Chicago). pp 165-74 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The operation of Anger gamma scintillation cameras in nuclear medicine is described and compared with rectilinear scanners. The various types of collimators available are illustrated. The advantages of the camera are its ready angulation, speed, and its large field of view. Technetium-99m is recommended as the best isotope to use to obtain the best compromise between sensitivity and resolution. Angiograms may be obtained with exposures of only 1 to 3 sec, and routine brain images are obtained in just a few min. (E.E.H.)

32244 ADVANCED IMAGING SYSTEMS: THE BETTER MOUSETRAP. Kenny, Peter J. (Univ. of Miami, Fla.). pp 175-9 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Performance limitations of radioisotope scanners and cameras are discussed, and possible areas for improvement or development are suggested.

32245 MULTICHANNEL ANALYZERS IN THE ANALYSIS OF THE RADIOISOTOPE CEREBRAL ANGIOGRAM. Witcofski, Richard L. (Bowman Gray School of Medicine, Winston-Salem, N. C.); Addario, Dominick; Maynard, C. Douglas; Janeway, Richard. pp 262-78 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The use of multichannel analyzer capability in an attempt to provide a more objective appraisal of vessel patency and vascularity is described. The results demonstrated the use of this method in a series of normal patients as well as several abnormals with commonly encountered intracranial lesions. (P.C.H.)

32246 GEOMETRICAL CORRECTION FACTORS FOR ANGULAR CORRELATION MEASUREMENTS WITH Ge(Li) DETECTORS. Barrette, J.; Lamoureux, G.; Monaro, S. (Univ. of Montreal). Nucl. Instrum. Methods; 93: No. 1, 1-11(1971).

A computer program calculation for the determination of the finite solid-angle corrections, for truly coaxial Ge(Li) detectors, is presented. The basis of these calculations is an exact knowledge of the differential efficiency of the detectors, i.e., the efficiency versus the position of irradiation on the detector surface. In order to calculate the differential efficiency of the Ge(Li) detectors two approaches were employed. The first is based on the probability of a direct photoelectric interaction of the γ-ray impinging on the crystal whereas the second is a Monte-Carlo simulation method. These calculations were carried out on four truly coaxial Ge(Li) detectors, which are currently employed in this laboratory. These counters have active volumes of 5.3, 32, 36 and 45 cm^3, respectively. The finite solid-angle corrections were calculated for source-detector distances of 3.0, 5.0, 7.0, 10.0 and 14.0 cm and for an energy range from 60 keV to 2.0 MeV. (auth)

32247 PROPORTIONAL COUNTER TELESCOPE FOR POSITION DETERMINATION AND PARTICLE INDENTIFICATION IN A MAGNETIC SPECTROGRAPH. Williams, N. (Rutgers-The State Univ., New Brunswick, N. J.); Kruse, T. H.; Williams, M. E.; Fenton, J. A.; Miller, G. L. Nucl. Instrum. Methods; 93: No. 1, 13-16(1971).

A position sensitive gas proportional counter employing resistive charge division has been used in the focal plane of a magnetic spectrograph. A second proportional counter acts as a ΔE detector which is used for particle identification. Good discrimination between protons, deuterons and α-particles is obtained. (auth)

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32248 SYSTEM FOR DETECTING COINCIDENCES BETWEEN A LARGE NUMBER OF COUNTERS USING A MINIMUM OF ELECTRONICS. Hellstroem, J.; Johnson, R. (Aktiebolaget Atomenergi, Studsvik, Sweden). Nucl. Instrum. Methods; 93: No. 1, 175-8(1971).

A technique has been developed for measuring coincidences between a large number of counters using the electronics needed for only two of them. Application is given to a Moxon–Rae detector. (auth)

32249 LEAKAGE CURRENT OF LITHIUM-DIFFUSED GERMANIUM DIODES AS A TOOL FOR LIFETIME MEASUREMENT. Schoenmaekers, W. K.; De Laet, L. H.; Guislain, H. J. (Metallurgie Hoboken-Overpelt NV, Olen, Belg.). Nucl. Instrum. Methods; 93: No. 1, 141-51(1971).

Li-diffused diodes are prepared from germanium material for use in lithium drifted gamma-spectrometers. At room temperature and above, the measured leakage current of these diodes is shown to be in close agreement with the theoretical diffusion current of an idealized N^+P junction. This diffusion current is numerically calculated and plotted, taking into account the temperature dependence of all parameters involved, except for the minority carrier lifetime. To compare theory with experiment, use is made of the room temperature resistivity and lifetime (as measured by the PCD method). Different assumptions of the theoretical model are tested. (auth)

32250 SOLID ANGLE SUBTENDED BY A CIRCULAR DISC. Gardner, R. P.; Verghese, K. (North Carolina State Univ., Raleigh). Nucl. Instrum. Methods; 93: No. 1, 163-7(1971).

The solid angle subtended by a circular disc from a point is approximated by the analytical expression for the solid angle for n-sided, regular polygon of area equal to that of the disc. When the point is farther from the plane of the disc than 0.1 the disc radius, polygons of 20 and 36 sides are required for approximating the solid angle subtended by the disc to within 1 and 0.1% respectively. In addition, the average solid angles subtended by circular discs from circular discs are calculated and given in tabular form for a range of disc sizes. (auth)

32251 LARGE-VOLUME PROPORTIONAL COUNTER. Jenkins, D. A. (Virginia Polytechnic Inst., Blacksburg. State Univ., Blacksburg, Va.). Nucl. Instrum. Methods; 93: No. 1, 169-70(1971).

A large-volume, atmospheric-pressure proportional counter constructed to detect 20 keV photons is described. (auth)

32252 INTRINSIC EFFICIENCIES OF SPHERICAL NaI(Tl) DETECTORS. Trombka, J. I. (Goddard Space Flight Center, Greenbelt, Md.). Nucl. Instrum. Methods; 93: No. 1, 119-23(1971).

The intrinsic efficiencies of spherical NaI(Tl) detectors are considered with respect to the efficiencies of cylindrical NaI(Tl) detectors. A simple method of calculating the intrinsic efficiencies of spherical detectors is presented. It is shown that the problems introduced by the dependence of detection efficiency on the angular distribution of the incident gamma-ray flux for cylindrical detectors can either be eliminated or greatly reduced by the use of spherical detectors. (auth)

32253 MONITOR REACTIONS FOR HIGH ENERGY BREMSSTRAHLUNG BEAMS. Di Napoli, V. (Univ., Rome); Margadonna, D.; Salvetti, F.; De Carvalho, H. G.; Benuzzi Martins, J. Nucl. Instrum. Methods; 93: No. 1, 77-81(1971).

The use of the $^{19}F(\gamma,n)^{18}F$, $^{27}Al(\gamma,x)^{24}Na$, $^{197}Au(\gamma,n)^{196}Au$, and $^{12}C(\gamma,x)^{7}Be$ reactions as absolute monitors for high-energy, high-intensity bremsstrahlung beams is discussed. The cross sections per equivalent quantum and the absolute cross sections, in the energy range 300 to 1000 MeV, are reported for these reactions. $^{19}F(\gamma,n)^{18}F$, $^{27}Al(\gamma,x)^{24}Na$, and $^{12}C(\gamma,x)^{7}Be$ reactions are proposed as very simple and suitable systems for monitoring purposes. (auth)

32254 SIMULTANEOUS RECORDING OF TRUE AND RANDOM COINCIDENCES USING A TWO-PARAMETER ANALYZER SYSTEM. Hattula, J.; Helppi, H. (Univ., Jyvaeskylae, Finland). Nucl. Instrum. Methods; 93: No. 1, 83-4(1971).

A description is given of a simple fast coincidence method which allows the simultaneous recording of coincidence and random coincidence spectra. The method is based on the properties of a standard two-parameter pulse-height analyzer system, and no special electronics is required. (auth)

32255 SIMPLE ZERO CROSSING PULSE SHAPE DISCRIMINATION SYSTEM. McBeth, G. W.; Lutkin, J. E.; Winyard, R. A. (Brighton Polytechnic, Eng.). Nucl. Instrum. Methods; 93: No. 1, 99-102(1971).

A new approach to pulse shape discrimination is outlined. The application of the system to neutron-gamma ray discrimination is described and results are presented which illustrate the degree of discrimination which can be achieved in practice. (auth)

32256 AUTOMATIC REMOTE-CONTROL SYSTEM FOR RECORDING GAMMA RADIATION. Voronin, A. P.; Klimov, A. N.; Nemirovskii, B. V. (All-Union Research Inst., Moscow). pp 109-16 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

It is shown how the specific characteristics of dosimetry data can be used in building reliable, centralized, remote-control systems to equip external dosimetry services, in which use is made of radio-communication channels for the transmission of information. Two variants for the design of such systems are examined: the first is for the interrogation of check points from a central control panel in accordance with a program laid down in the control panel; the second is for the transmission from time to time of information from the check points in accordance with a program laid down in the check points. Some ideas are given for reducing the quantity of electronic equipment in the systems. It is shown that the governing factor is the design of the check-point measurement channel. Possible variants in the design of the measurement channel are considered and specific block diagrams are given in which the data are presented on linear and logarithmic scales. It is shown that a measurement channel design involving preliminary compression of the data for transmission is more rational. A description is given of the operational principle of the TMDU-1 telemetric multichannel dosimetric system, intended for measuring the gamma-radiation levels at the check points and transmitting the measurement results along radiocommunication channels to the central control panel. The technical parameters and principal functions of the system are described. Its operation is examined, and block diagrams for the measurement channel and modulator element are given. (auth)

32257 USA STANDARD AND IEEE TEST PROCEDURE FOR SEMICONDUCTOR RADIATION DETECTORS (FOR IONIZING RADIATION). ANSI N 42.1 1969. New York; Institute of Electrical and Electronics Engineers, Inc. (1969). 12p. Available from Inst. of Electrical and Electronics Engineers, New York.

Standard test procedures for determining the electrical characteristics and the radiation detection characteristics of semiconductor detectors are described. Electrical characteristics include current–voltage characteristics, capacitance–voltage characteristics, noise measurement by pulse-height distribution, noise measurement by oscilloscope and root-mean-square voltmeter, nose linewidth as a function of amplifier time constants, detector noise spectrum measurements, detector electric rise time, ambient sensitivity, and vibration and environmental tests. Radiation detector characteristics include dead layer determination, delineation of sensitive area, measurement of sensitive thickness, gamma ray counting efficiency, charge collection time, spectral resolution, and radiation damage measurements. (W.H.K.)

32258 USA STANDARD AND IEEE TEST PROCEDURE FOR AMPLIFIERS AND PREAMPLIFIERS FOR SEMICONDUCTOR RADIATION DETECTORS (FOR IONIZING RADIATION). ANSI N 42.2 1969. New York; Institute of Electrical and Electronics Engineers, Inc. (1969). 19p. Available from Inst. of Electrical and Electronics Engineers, New York.

Standard test procedures are described for noise or linewidth measurements, preamplifier noise performance, main amplifier noise, pulse height linearity, count-rate effects, overload effects, pulse-height dependence on rise time, pulse-height stability, and crossover walk. (W.H.K.)

32259 POSSIBILITY OF IMPROVING THE SIGNAL-TO-NOISE RATIO FOR NUCLEAR PULSE AMPLIFIERS INTRODUCING DECOUPLING NETWORKS BETWEEN DETECTOR AND AMPLIFIER INPUT. Bussolati, Camillo (Politecnico, Milan); Cova, Sergio; Gatti, Emilio. Z. Angew. Math. Phys.; 22: 14-25 (25 Jan 1971).

A study to determine if the use of decoupling networks between a semiconductor detector and the charge preamplifier could improve the signal-to-noise ratio is described. Idealized decoupling networks were considered. The proposed technique allows a theoretical improvement of signal-to-noise ratio by a factor of 1.22 that can be obtained only with ideal inductors. From a practical standpoint, a possible objection might be the increased complexity of the circuits required. (W.H.K.)

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32260 CALIBRATION OF BORON-COVERED MULTISPHERE DETECTORS USING RESONANCE ACTIVATION FOR NEUTRON SPECTROMETRY IN THE keV REGION. Binney, Stephen Ellis. Berkeley, Calif.; Univ. of California (1970). 128p. University Microfilms Order No. 71-9766.

Thesis.

A set of neutron spectrometers were experimentally calibrated at several neutron energies in the keV region. Experimental results were compared with calculations performed using a one-dimensional, discrete ordinate transport theory code. The spectrometer detectors were cadmium covered indium spheres surrounded by various sized polyethylene moderating spheres. Some of the detectors had an additional layer of boron around the polyethylene. The neutron source used for the calibration was produced by utilizing the photoneutron reaction in beryllium, which is fairly monoenergetic. The gamma ray source consisted of an aqueous solution of a desired isotope which was irradiated by circulation in and out of a reactor beam port. Different neutron energies were produced by changing the gamma ray source. In addition a solid calibrated antimony–beryllium neutron source was used for normalization of the data. Response functions were calculated for each of the spectrometer detectors as a function of incident neutron energy. Experimental activities of the indium activation spheres were typically about 20% different from the activities calculated from the computer code. (Diss. Abstr. Int., B)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 32090, 34082, and 34359.

32261 (IA–1231) MONTE CARLO PROGRAM FOR CALCULATING THE INTERACTIONS BETWEEN A NUCLEAR SPECTROMETER AND A PULSE GENERATOR AT HIGH COUNTING RATES. Wiernik, Miguel (Israel Atomic Energy Commission, Tel Aviv). Sep 1970. 50p. Dep. NTIS (U. S. Sales Only).

The program DEADTIME was written in order to calculate the extent of the interactions between the pulses from a pulse generator and a multichannel analyzer when the former is used to correct the measurements of the latter for dead-time effects. The accuracy and the precision of the correction factor can be calculated beforehand for each particular set of conditions and instruments. The accuracy was found to depend only on the ratio between the rates of the pulses from the pulse generator and the detector. Instructions for the choice of the best working conditions are given. The use of a pulse generator is especially recommended for the measurement of very short-lived nuclides where the dead-time varies continuously and cannot be compensated for automatically by means of a live-timer. (auth)

32262 (PEL–207) PEAK: A COMPUTER PROGRAMME FOR THE ANALYSIS OF TIME-OF-FLIGHT SPECTRA. Tepel, J. W. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Nov 1970. 47p. Dep. NTIS (U. S. Sales Only).

A computer program is described which has been developed for the analysis of neutron time-of-flight spectra. The program identifies the background and approximates it by a straight line or parabola, after which complex peak formations are resolved into their constituent lines by the multiple superposition of a reference peak of any predetermined shape, but using the height, width and position as variable parameters in a least squares procedure. No prior information on the position or number of lines is needed. (auth)

32263 PORTABLE PRECISION DOSIMETER WITH SEVERAL MEASURING RANGES FOR HIGH-ENERGY X-RAY AND ELECTRON RADIATION. Nagl, Johann; Haider, Johann G. (Internationale Atomenergie-Organisation, Vienna). Strahlentherapie; 140: 663-6(Dec 1970). (In German).

A precise measuring instrument for ionization measurements is described; its measuring range between 1 and 1000 R can be adjusted in a simple manner. The measuring system consists of a modified Townsend compensation system. The measuring accuracy can be increased, by an interiorly fixed compensator with a standard cell, to better than ±0.1. The device can be used with the described ionization chamber for comparing measurements of ion dose. (auth)

32264 GAMMA SPECTROMETRY IN DRILLINGS USING A GeLi SEMICONDUCTOR PROBE. Dumesnil, Patrice; Andrieux, Claude (CEA, Saclay, France). Ind. At.; 14: No. 11-12, 29-40(1970). (In French).

A radio-coring probe is described, which uses Ge(Li) detectors. The apparatus incorporates a liquid nitrogen cryostat and a winch with a pipe for evacuating the gaseous nitrogen; the equipment was used successfully in the uranium bearing drillings of the Lodeve region. The way in which uranium contents are determined from the results obtained is shown. Further applications of the method are suggested such as x ray fluorescence, analysis by activation, and in situ gamma ray spectrometry. (auth)

32265 INTERACTION OF 14.0-MeV NEUTRONS WITH ^{12}C IN STILBENE. Fabian, H.-U. (Univ., Kiel). Z. Naturforsch.; 26a: 317-19(Feb 1971).

The pulse-height spectrum of all heavy charged particles induced by 14.0-MeV neutrons in a 1″ × 1″ stilbene scintillator was measured using a pulse-shape discriminator and the associated-particle technique. The proton pulse spectrum was subtracted, and the remaining alpha-pulse distribution is shown in a diagram. The sum of the cross sections for the reactions $^{12}C(n,n')\,3\alpha$ and $^{12}C(n,\alpha)^9Be$ was determined to be $\sigma_c = (260 \pm 20)$ mb. (auth)

32266 AUTOMATIC DEVICE FOR β-SPECTROMETER MEASUREMENT CONTROL. Thiel, K.; Maeggi, H. G. (Univ., Cologne). Nucl. Instrum. Methods; 93: No. 1, 57-9(1971).

An automatic device to drive a double focusing magnetic beta-ray spectrometer has been built and successfully run for several months. Simple digital steering equipment allows spectrometer current values to be reproduced to better than 1.3‰ of the chosen spectrometer current interval. Plan and function of the automatic device are described. (auth)

32267 INTERMEDIATE SCATTERING FUNCTIONS OBTAINED BY FAST FOURIER TRANSFORMATION OF COLD NEUTRON TIME-OF-FLIGHT SPECTRA. Bregman, J. D.; DeMul, F. F. M. (Interuniversity Reactor Inst., Delft, Netherlands). Nucl. Instrum. Methods; 93: No. 1, 109-18(1971).

The influence of the finite resolution of the spectrometer in cold neutron time-of-flight spectra is studied. It is shown how by direct numerical fast Fourier transformation of these spectra, intermediate scattering functions can be obtained from which the resolution is removed. Under certain conditions depending on the scattering law of the sample and the resolution function it is possible to calculate reliable double-differential scattering cross sections. A short description of the Fortran program used in the calculations is given, together with some applications of the method. (auth)

32268 ELECTROSTATIC ELECTRON ENERGY ANALYSER FOR 3 TO 20 keV ELECTRONS. Hale, D. P.; Allen, W. D. (Univ. of Reading, Eng.). J. Phys., E (London); 4: No. 4, 311-16(Apr 1971).

An electrostatic energy analyser was developed to determine the energy spectra of electrons present in 1 to 10 mA beams from hollow-anode gas-discharge guns operating between 3 and 20 kV. Basically the instrument employs the electrostatic field between charged, concentric cylinders to achieve dispersion. Focusing conditions similar to those predicted by Hughes and Rojansky (1929) were obtained by using deflection through 90° instead of the 127° used by those authors. These conditions were achieved by determining suitable positions for the entrance and exit slits and by using an aperture stop to limit the angle of the wedge-shaped beam of electrons entering the cylindrical plates. Predictions concerning the change in image position with energy, the calibration curve, energy resolution and shape of the output curves were made and largely verified experimentally. Various difficulties encountered are discussed. Most of the experiments concerning the properties of the analyser were carried out using electrons from a thermionic source; having established those properties, the analyser was used to determine energy spectra from hollow-anode gas-discharge guns. (auth) (UK)

High Energy Physics Instrumentation

32269 (CEA-CONF–1735) SUPERCONDUCTING MAGNET OF THE CERN BUBBLE CHAMBER. Florent, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 17p. (In French). (CONF-700341–3). Dep. NTIS (U. S. Sales Only).

From Panel on superconductors; Paris, France (17 Mar 1970).

The superconducting magnet intended for the giant bubble chamber at CERN is described, and its principal characteristics are given. The different problems which have arisen during its development are examined, and the solutions currently adopted are described. (France)

32270 (JINR–P13-5623) ON NEW POSSIBILITIES OF QUICK RECORDING OF PARTICLE TRACKS IN CONDENSED MEDIA. Pisarev, A. F. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

New methods of quick recording of particle tracks in condensed media are considered. Some of them are based on the impact multiplication of primary charges in the particle tracks on the impurity levels, artificially populated by electrons, in cooled solid states. A number of methods is based on the effect of enhanced tunnel penetration of electrons in the points where particles are passing through the thin layers of semiconductors and dielectrics. (auth)

32271 (SGAE-PH-103/1970) DEVELOPMENT OF A DETECTOR WITH LOW BACKGROUND FOR COUNTING LIGHT, LOW-ENERGY IONS. Benka, Oswald (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Vienna). 1970. 84p. (In German). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Vienna Univ., Austria.

For investigating the beta-decay of the neutron, an energy-independent detector has been developed to count the low energy (150 to 800 eV) recoil protons. Since only a few protons are expected per minute, background should be low. The detector is an improved ion-electron converter. Ions entering the ion-optical system are accelerated to −25 kV and hit a foil at an angle of 45°. Ions of different energies are focussed at the foil by using a variable potential on one lens diaphragm. Secondary electrons are ejected from both sides of the foil, accelerated in opposite directions, focussed upon two separate scintillators and counted in coincidence. The foil is thin enough to prevent heavier ions from being counted. Since the foil is in an almost field-free space and because of the coincidence condition, the background contributions due to field emission and due to scintillator-photomultiplier noise are reduced. The necessary ion-optical systems are developed and calculated by a computer program. The focussing properties are given. The manufacture of the thin foils, and the variable voltage supply are described. The detector was tested with ions from an ion source. The properties of the ion optical systems were found to agree with calculations. (auth)

32272 POSSIBILITY OF CONSTRUCTING LARGE DETECTORS FOR NEUTRINO ASTRONOMY. Bogatyrev, V. K. Yadern. Fiz.; 13: 336-8(Feb 1971). (In Russian).

A question is considered of detecting neutrino flashes of collapsing stars from remote galaxies at distances of 7 to 10 millions light years. For this purpose the construction of an antineutrino detector of $\sim 10^7$ t weight is necessary. A Cherenkov detector on the basis of distilled water is considered. The construction of special photomultipliers seems to enable one to construct a cheap detector. (auth)

Radiation Dosimeters

Refer also to abstract 32415.

32273 (CEA-R-4173) ADVANTAGES OF A TEFLON–CARBON MIXTURE IN THE CONSTRUCTION OF CAVITY IONIZATION CHAMBERS MEASURING THE ABSORBED DOSE IN AIR. Simoen, Jean-Pierre; Sklavenitis, Laodamas; Troesch, Gilbert; Pages, Lucien (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1971. 23p. (In French). Dep. NTIS (U. S. Sales Only).

The theoretical calculation of the absorbed dose in the air from that measured in a cavity within a given material enables one to establish the necessary correction factor as well as the condition of equivalence of two materials from the dosimetric view-point. A comparative study of various materials currently used in the construction of ionization chambers, for example graphite, nylon, etc., with a Teflon-carbon mixture reveals that this mixture is an excellent air equivalent material and particularly suitable for cavity ionization chambers. (auth)

32274 (KFK-1323) USE OF A DIFFERENTIAL READ-OUT METHOD FOR PHOSPHATE GLASS IN PERSONAL DOSIMETRY. Kiefer, H.; Piesch, E. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1970. 29p. (In German). Dep. NTIS (U. S. Sales Only).

Measurements were made in the energy range from 10 keV to 1.2 MeV and with angle of incidence between 0 and 180° with glass dosemeters on an Alderson man-like phantom. The dosemeters were exposed at the surface of the phantom at chest height. The results showed that it is possible to obtain additional information about the radiation quality and the direction of incidence with phosphate glass personal dosemeters using the differential read-out method. The discussion reviews the possibility of correcting the body dose for backscatter and the possibility of using this method of personal dosimetry with different examples of dosemeters. (auth)

32275 (SC-T-71-3011) MEASUREMENTS OF NEUTRON FLUX BY ACTIVATION FOR CALIBRATING A FILM BADGE. Busuoli, G.; Cavallini, A.; Fasso, A.; Rimondi, O. Translated by Anna Vakar (Sandia Labs., Albuquerque, N. Mex.), from Symposium on Neutron Monitoring for Radiological Protection, Vienna, Austria, August 29, 1966. 17p. (CONF-660807-42). Dep. NTIS.

As the first step in the design of a film badge for thermal and epithermal neutrons, fluxes of different composition from a radioactive source immersed in water were calibrated. The neutron fluxes were evaluated on the basis of the activation of gold foils irradiated both with and without cladding so that the thermal and epithermal components could be distinguished. The measurements of the activity of the gold foils, made with a low-background gas-flow counter, were corrected by taking into account the effects of flux depression, self-shielding, self-absorption and back-scattering. After ascertaining the flux value, measurements to determine the effects due to activation of the Ag–Br contained in the Kodak photographic ("Radiation Monitoring") emulsion were undertaken to compare the results obtained with the theoretical calculation. Also, a study to devise a system of shields for insertion in the badges to make the film response proportional to the dose due to either component of the neutron flux is described. (auth)

32276 COMMENT ON A SIMPLE PHOTOGRAPHIC FILM DOSIMETER OF LOW FREQUENCY DEPENDENCE. Van Stekelenburg, L. H. M.; Julius, H. W. (Radiological Service Unit TNO, Arnhem, Netherlands). Health Phys.; 20: 452(Apr 1971).

The film badge system which was adopted in the Netherlands in 1956 and is still in use is very similar to the one proposed by Tait, (Health Phys. 13, 289 (1970)), even in such details as filter thickness (2.0 mm tin). Unlike Tait however, two different films are used to cover the energy ranges (the films having been selected to give an even response). Since the sum of their densities is energy independent within 20%, one single reading of both films together is sufficient for the measurement of exposure. Another advantage of using two matched films is that the detection threshold becomes virtually independent of energy. (UK)

32277 COMMENT ON QUARTZ AS A DOSIMETER. McDougall, David J. (Loyola Coll., Montreal). Health Phys.; 20: 452-3(Apr 1971).

Reference is made to work on the enhancement of the thermoluminescence of quartz by an annealing treatment, reported by Fleming and Thompson (Health Phys. 18: 567 (1970)) which used unfiltered x rays instead of β radiation and no preliminary firing was carried out. Results different from those reported by Fleming and Thompson were obtained for the change in sensitivity (S/S_0) after annealing at 600°C and for the saturation curves after irradiation. Comments are made on the proposed method of using the change in sensitivity for dosimetry. (UK)

32278 CONTRIBUTION TO FILM DOSIMETRY OF HIGH-ENERGY RADIATION. PART 2. CRITERIA FOR OPTIMIZING CONDITIONS CONCERNING THE DEVELOPING OF FILMS IN DOSIMETRY. Rassow, Juergen (Ruhr Univ., Essen). Strahlentherapie; 140: 655-62(Dec 1970). (In German).

A quantitative attribution of doses to film density requires the knowledge of the gradation curve valid for the energy spectrum at the film position. An examination of the influence of the developing parameters, temperature, and time for the general case of a falciform gradation curve, as well as for the special case of an extremely linear curve, up to density values $S = 5$, renders possible a precise wording of items for optimization and of the requested tolerances of the spatial and temporal constancy of development conditions. (auth)

32279 MASS DEPENDENCE OF THE SENSITIVITY OF LiF–TEFLON MICROROD DOSIMETERS. Orton, C. G.; Seibert, Joan B. (New York Univ. Medical Center). Int. J. Appl. Radiat. Isotop.; 22: 260-3(Apr 1971).

The various factors limiting the accuracy of LiF-Teflon microrod dosimeters are considered. The results of a study of the effect of variations in dosimeter mass and hence in LiF powder content are presented. The extent to which length and diameter changes contribute to mass variation was investigated and the relationship between TL response and mass was considered. (UK)

32280 CALIBRATED U-TH GLASSES FOR NEUTRON DOSIMETRY AND DETERMINATION OF URANIUM AND THORIUM CONCENTRATION BY THE FISSION TRACK METHOD. Schreurs, J. W. H. (Corning Glass Works, N. Y.); Friedman, A. M.; Rokop, D. J.; Hair, M. W.; Walker, R. M. Radiat. Eff.; 7: 231-3(Feb 1971).

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A series of standard uranium glasses was prepared. A primary standard containing 41 ppM of added U had its concentration and isotope ratio verified by mass spectrometry and by fission track techniques. Secondary standards were compared to the primary standard using the fission track technique. These glasses are useful for measuring both Th and U in solids. The U concentration in an unknown is determined by comparing the fission track density induced by thermal neutron irradiation with the corresponding density in the standard. Th is measured by a cyclotron irradiation using the same U standards. The glasses are also useful for neutron dosimetry. Investigators may obtain small samples of most of these standards from R. H. Brill of the Corning Museum of Glass. Although most of the glasses were fabricated from depleted uranium, one standard containing natural uranium is available. A standard Th glass with concentration of 41 ppM was also made. (auth)

32281 FURNACE AND CONTROLLER GIVING A CONSTANT RATE OF TEMPERATURE RISE FOR THERMOLUMINESCENCE STUDIES. Ausin, V.; Herrero, J.; Goni, A. J.; Alvarez Rivas, J. L. (Junta de Energia Nuclear, Madrid). J. Phys., E (London); 4: No. 4, 289-90(Apr 1971).

With a Wheatstone bridge and a proportional controller, a linear heating system was developed. The heating power is controlled in full. The heating rate can be varied between 5 and 80 deg C min^{-1}. It can be used for any range of temperatures with very simple changes; the one described operates between 0 and 400°C. This controller can also be used to keep the furnace temperature constant. By using nonlinear potentiometers, different heating functions can be obtained. (auth) (UK)

32282 THERMOLUMINESCENT SENSITIVITY OF CaF_2:Mn IN A MIXED NEUTRON-GAMMA FIELD. Puite, K. J. (EURATOM–ITAL, Wageningen, Netherlands). Health Phys.; 20: No. 4, 437-42(Apr 1971).

The thermoluminescent sensitivity of CaF_2: Mn in a mixed field of thermal or fast neutrons and gamma rays as a function of both components of the irradiation was studied. No permanent change in TL sensitivity for gamma rays was found after irradiation with thermal-neutron fluences up to 4×10^{12} n/cm^2 and fast-neutron fluences up to 8×10^{13} n/cm^2. CaF_2 irradiated with ^{137}Cs gamma rays followed or preceded by a fast-neutron irradiation did not show significant differences in TL response. A model was developed to explain the fast-neutron sensitivity observed, and the apparent dependence of this sensitivity on neutron energy is discussed. (auth) (UK)

32283 SOME INTRINSIC INACCURACIES OF THERMOLUMINESCENT DOSIMETRY. Kartha, M. (Ohio State Univ., Columbus). Health Phys.; 20: No. 4, 431-5(Apr 1971).

A majority of the users of thermoluminescent dosemeters employ commercially available TLD readers and phosphors. During 7 yr of experience with thermoluminescent dosimetry a few important, but generally overlooked, problems which are inherent to the system were observed. The non-uniform heating cycle, the position of the reference light source and the dependence of thermoluminescence on the crystal size of LiF can introduce an error of up to a maximum of 30% in the dose measurements with TLD-100. Most of this inaccuracy can be eliminated by using careful techniques and simple modifications in the design of the reader. (auth) (UK)

32284 NEW ASPECTS IN APPLICATION OF EXOELECTRONS. Kramer, J. PTB Mitt.; 80: 343-50(Oct 1970). (CONF-700715-3).

From 3rd International Symposium on Exoelectrons, Brunswick, West Germany (6 Jul 1970).

New applications of exoelectrons in the field of dosimetry are reported including a comparison of thermal and optical stimulation (TSEE-OSEE), the effects of saturation and supralinearity, the influence of gaseous environment and the range of secondary electrons. With optical stimulation using neutral density filters 8 orders of magnitude of x-ray dose can be measured with a GM-counter. Linearity of OSEE versus irradiation dose and also versus stimulating light intensity depends on the conductivity of the matrix. Nonlinearity is caused during the emission, not during the irradiation. The influence of external electric charges is studied. For OSEE-applications impregnated paper matrixes are used. Exosensitive papers are also used in an apparatus for demonstrating photographic applications. A similar OSEE-technique is applied to the investigation of heterogeneous solids (crystals, minerals). Several new sources of tribo- and chemo-induced exoelectrons are given, hypothetic mechanisms of these effects are discussed. (auth)

32285 PROGRESS IN EXOELECTRON DOSIMETRY. Becker, K.; Cheka, J. S.; Gammage, R. B. PTB Mitt.; 80: 334-42(Oct 1970). (CONF-700715-2).

From 3rd International Symposium on Exoelectrons, Brunswick, West Germany (6 Jul 1970).

After a brief historical survey of investigations on the possible use of exoelectrons in radiation dosimetry, recent results obtained at ORNL are described in some detail. This work was based on Kramer's observation that the addition of a conductor to a material that exhibits TSEE (thermally stimulated exoelectron emission) increases the reproducibility of its radiation response. Detectors which were highly sensitive and showed good reproducibility ($\sigma = 2\%$) were made from ceramic BeO by optimal impregnation with inert, high-melting metals such as Pt, Pd, and Au. The metal is first vacuum deposited on the surface and then diffused thermally into the bulk. The impregnation with Pt and Pd, but not Au, substantially increases the response over that of the untreated ceramic due probably to a reduction in the work function of the BeO. Dose measurements in the μR range become feasible. The response is not a linear function of dose. Other characteristics of metal-impregnated ceramic BeO detectors such as fading, energy response and spurious signals are described together with efforts to optimize their properties for use in dosimetry. Some results of ESR studies are discussed briefly. (35 references) (auth)

32286 THERMOLUMINESCENCE PERSONNEL DOSIMETRY AT HANFORD. Kathren, R. L.; Kocher, L. F.; Endres, G. W. R. (Battelle-Northwest, Richland, Wash.). Amer. Ind. Hyg. Ass. J.; 32: 230-4(Apr 1971).

In mid-1967, a flexible rubber finger ring utilizing a lozenge-shaped wafer of ^7LiF in a Teflon matrix was introduced for routine hand dosimetry at Hanford. The thermoluminescence ring dosimeter provided a significant improvement over previously used film dosimeters, having a useful range of 0.02 to 10^5 R with a standard deviation of ±10%, minimal energy dependence, and resistance to the environment. Subsequently, a basic dosimeter with a range of 0.02 to 10^5 R was introduced for personnel who do not routinely work with ionizing radiation. This dosimeter utilizes a single ^7LiF block—$3.2 \times 3.2 \times 0.9$ mm—for routine readout and an 8-mm-diameter ^7LiF-Teflon disk as backup, sealed in an individually identified card. Precision was excellent, with a standard deviation of 7.5% at 90 mR. A more sophisticated dosimeter, which will provide dose data for photons and betas as well as neutrons, is in the final stages of development. Also, a fully automated readout system now under development will permit interpretation with a minimum of time and manual input. A low-level environmental dosimeter and miscellaneous field applications are discussed. (auth)

32287 STANDARD METHOD OF TEST FOR ABSORBED GAMMA RADIATION DOSE IN THE FRICKE DOSIMETER. ASTM D 1671 1963. Philadelphia; American Society for Testing and Materials (1965). 3p. Available from American Society for Testing and Materials, Philadelphia.

The apparatus, reagents, calibration, procedure, and equations for measurement of gamma radiation in the range of 0.2×10^4 to 4×10^4 rads by oxidation of ferrous ammonium sulfate (Fricke dosimeter) and determination of the ferric ion concentration spectrophotometrically are described. (W.H.K.)

Radiometric Instruments

Refer also to abstracts 31824, 32157, 32209, and 32371.

32288 (AERE-R–6308) IMPROVED ELECTRONIC ARRANGEMENT FOR BERYLLIUM MONITORS. Rolls, A. T. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 14p. Dep. NTIS (U. S. Sales Only). UK 23p.

Microgram quantities of beryllium may be measured by utilizing a γ–n reaction in beryllium, and counting the resulting neutrons in a ring of BF_3 counters immersed in a neutron thermalizing medium such as polythene, borax, or paraffin wax. Hitherto most such monitors have employed BF_3 counters connected in parallel and feeding a common amplifier/discriminator. An arrangement is described whereby each counter has its own amplifier/discriminator. The advantages of this arrangement are given with particular reference to the reduction of background arising from γ-pulse pile-up, the enhanced immunity from environmental electrical interference and the easier identification, isolation or replacement of a faulty counter. (auth) (UK)

32289 (CEA-R–4107) MACH METER USING SEMICONDUCTOR DETECTORS FOR NUCLEAR RADIATION. Gilly, Louis;

Jourdan, Paul; Denis, Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jan 1971. 12lp. (In French). Dep. NTIS (U. S. Sales Only).

The described machmeter uses semi-conductor detectors. It detects alpha particles produced by americium 241 sources. Pulses issued from each of these detectors are amplified and dispatched in two electronic chains. They get in a simplified calculator which gives Mach number. It is possible to associate electronic chains for obtaining separate information of altitude and Mach number. It may be used for stabilizing altitude. This report studies different parameters among which there are variations of counting. Systematic analysis of experimental errors is made. (auth)

32290 INVESTIGATION OF RADIOISOTOPE SOURCES AND X-RAY DETECTORS FOR RENTGENORADIOMETRIC ANALYSIS. Kozlov, O. V.; Mamikonyan, S. V.; Martishchenko, L. G. (Scientific Research Inst. of Radiotion, Moscow). Izotopy SSSR; No. 17, 3-11(1970). (In Russian).

A brief review is given of various radioisotope sources and x-ray detectors and filters used in x-ray fluorescence analyses. The performance and applications of these devices under various conditions are discussed. (tr-auth)

32291 NUCLEONIC MEASURING APPARATUS WITH AUTOMATIC FIRE SAFETY RADIATION SOURCE SHUTTER CLOSING AND LOCKING MEANS COMPRISING A SPRING RETAINED BY A FUSIBLE BARRIER WHICH MELTS AT HIGH TEMPERATURES. Trachevski, George J.; Auborn, Ernest A. (to Industrial Nucleonics Corp.). U. S. Patent 3,562,531. 9 Feb 1971. Filed 27 Apr 1967.

A nucleonic measuring instrument is described wherein a housing contains a radiation source and has an aperture controlled by a shutter that is spring-loaded to a closed position for confining and shielding the radiation and is movable by a motor to an open position for releasing the radiation. The motor is supplied with power through a heat-sensitive element so that it is deenergized and the shutter closes in response to a predetermined high ambient temperature, such as may be caused by a fire. A spring steel shutter lock is retained in a retracted position by a barrier of meltable metal that is adapted to melt and release the spring lock at a still higher ambient temperature for locking the shutter in its closed position. (auth)

32292 NEUTRON-GAMMA RAY WELL LOGGING APPARATUS EMPLOYING SPACED GAMMA RAY DETECTORS. Lawson, Bobby L. (to Phillips Petroleum Co.). U. S. Patent 3,562,526. 9 Feb 1971. Filed 17 Oct 1967.

A neutron–gamma ray well-logging device comprises a neutron source and two spaced gamma-ray detectors. The detectors are shielded so that only gamma rays that emerge from the formations at a predetermined angle are allowed to strike the first detector. Only gamma rays which are emitted from the first detector at a predetermined angle are allowed to strike the second detector. (auth)

32293 ^{63}Ni ELECTRON CAPTURE DETECTOR. Taylor, Donald F.; Peters, Urban James; Schmit, John A. (to Hewlett-Packard Co.). U. S. Patent 3,566,107. 23 Feb 1971. Filed 24 Nov 1967.

A gas ionization detector is constructed to have a stacked array of individual elements together defining a scaled cavity disposed within mating cylinder and piston-housing members. The piston is adapted to engage the hollow cylindrical housing. Disposed within the cylindrical housing is a first electrically nonconductive washer, a disclike anode electrode, a second electrically nonconductive washer, and a disc element containing the radioactive material. Mounted within a bore formed in the piston portion of the housing is a thrust bearing, a spacer washer, and a disclike cathode electrode. A tube extending through the spacer washer of the piston element communicates with the outside of the detector. An orifice in the cylindrical housing provides a second access to the outside of the detector. When the piston-housing member is inserted into the cylindrical housing and tightened, the stacked elements within the housing form an inner sealed cavity that is capable of relatively high temperature operation and facilitates removal and replacement of the radioactive material. (auth)

32294 PORTABLE BETA BACKSCATTER MEASURING INSTRUMENT ASSEMBLY. Weinstock, Jacques J.; Hay, William D. (to Unit Process Assemblies, Inc.). U. S. Patent 3,560,742. 2 Feb 1971. Filed 17 Jan 1967.

A portable beta backscatter measuring instrument for measurements of the thickness of coatings on workpieces is described. An adjustable jig-mounted, portable probe member engages a workpiece, or an abutment fixed relative to a workpiece, to hold the probe member firmly to a surface of the workpiece in proper position for measuring the thickness of a coating on the surface. (auth)

32295 ANGULAR TRACKER RESPONSIVE TO PENETRATING RADIATION. Joyce, William B. (to Industrial Nucleonics Corp.). U. S. Patent 3,562,528. 9 Feb 1971. Filed 9 May 1967.

A system is disclosed for deriving a direct digital indication of the position of a penetrating-radiation source, e.g., a gamma-ray or x-ray source. A detector array having multiple channels with the same field of view is irradiated by the source. Each channel includes a different number of radiation-receiving areas to derive the digital indication. The detector array, in certain embodiments, is shielded with a slit plate or shadow mask. In another embodiment, a single multiple-detector channel is shielded with a shadow mask and step changes in illumination of each detector drive a position indicating counter. (auth)

32296 DETECTION AND MEASUREMENT OF TRACE GASES WITH A METASTABLE-HELIUM DETECTOR. Lutz, M. (Centre d'Etudes de Bruyeres-le-Chatel, France). pp 203-14 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The principle of the metastable-helium detector is described: the trace gases are ionized by means of excited helium molecules produced by the action of beta particles emitted from a 250-mCi source consisting of tritium absorbed in a tritium foil. In this way it is possible, after separation in a suitable chromatographic column, to detect all gases whose ionization potentials are lower than that of helium and in particular those (e.g., hydrogen, noble gases, sulphur and nitrogen oxides) for which a flame ionization detector gives no response. Calibration curves were plotted for determining different proportions of the components of gas mixtures; the detection limits varied between 0.2 pp 10^9 and 5 pp 10^9, depending on the gases in question. The calibration standards, which are of very low concentration, were obtained by the exponential dilution method. The detector has been used for determining hydrogen in air (~1 pp 10^6), traces of krypton and xenon in different gas mixtures, and certain nitrogen oxides. (auth)

32297 ANALYSIS OF SULPHUR COMPOUNDS OF INDUSTRIAL COMBUSTION GASES BY MEANS OF AN ELECTRON-CAPTURE TYPE DETECTOR. Lasa, J.; Korus, A.; Kilarska, Maria (Academy of Mining and Metallurgy, Krakow). pp 215-21 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

Sulphur compounds, such as CS_2, SO_2, COS and H_2S, occurring in industrial combustion gases present a dangerous environmental pollution problem. The results of the analysis of these compounds by gas chromatography using an electron capture-type detector are presented. The analysis of SO_2 and CS_2 was made on a chromatographic column 70 cm long and 4 mm in diameter filled with Celite covered with polyethylene glycol. H_2S and COS were separated on the column 30 cm long and 3 mm in diameter filled with silica gel. For detection an electron capture-type detector with a ^{63}Ni source was used with nitrogen as carrier gas in the dc or pulse modes of operation. The universal detector, which can work as well as a cross-section, argon and electron capture-type detector, is described. The compounds mentioned above were also detected by argon and helium detectors. The results of these investigations are presented. It was found that 5 ppM SO_2 and 2×10^{-3} ppM CS_2 can be detected by the electron capture-type detector. (auth)

32298 METHOD AND APPARATUS FOR MEASURING RATES OF RANDOM PULSES AND ALARM ACTUATED THEREBY. Homer III, John C.; Stock, John R. (to Stock Equipment Co.). U. S. Patent 3,551,672. 29 Dec 1970. Filed 28 Jun 1967.

An apparatus for discriminating between rates of pulses that occur randomly in time, such as pulses derived from emissions by radioactive materials, and an alarm, such as an alarm for indicating a reduction in the flow of material through a conduit, controlled by the circuit, are described. The apparatus discriminates betweeen different rates of occurrence of pulses by comparing the interval between successive pulses to a predetermined but variable interval and providing electrical pulses — "down pulses" — corresponding to radiation pulses occurring at intervals greater than the predetermined interval and electrical pulses — "up pulses" — occurring at intervals less than predetermined interval. These

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"up pulses" and "down pulses" may be utilized, for example, to give an indication of a rate of radioactive emission or to actuate an alarm or control. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 32742, 33891, and 33935.

32299 (CERN-Trans-71-6) HIGH-VOLTAGE MULTICHANNEL PULSE GENERATOR. Belyakov, E. S.; Davidyan, D. B.; Markar'yan, A. A.; Kharitonov, V. M. (Akademiya Nauk Armyanskoi SSR, Erevan. Institut Fiziki). Translated by F. Quanquin (CERN, Geneva, Switzerland), from report ERFI-MLE-69-2. 8p. (In French). Dep. NTIS (U. S. Sales Only).

A description is given of a high-voltage multichannel pulse generator equipped with six outputs. The pulses of the output can have an amplitude of 2 to 20 kV. The generator is triggered by a pulse of any polarity having an amplitude of ~500 V. The delay of the generator is 17 nsec for an output pulse of 4.4 kV and 38 nsec for an output pulse of 18.5 kV, the front of the high voltage pulse being equal respectively to 1.5 and 4.0 nsec. The energy storage in the generator reaches ~6 joules. (tr-auth)

32300 (CONF-700221) PROCEEDINGS OF THE SYMPOSIUM ON ELECTRONICS (MICROWAVE TECHNOLOGY), BOMBAY, FEBRUARY 25-27, 1970. (Department of Atomic Energy, Bombay (India). Committee on Electronics). 1970. 436p.

Separate abstracts were prepared for 2 of the 31 included papers. The remaining papers were not in the scope of NSA and hence omitted. (M.O.W.)

For abstracts of individual papers see: 33344 and 33345.

32301 (EGG-1183-2262) ORGANIC DYE LASER HIGH-POWER OPTICAL CARRIER. (Excerpt from AEC R and D Final Report No. EGG-1183-2244, S-498-R, Published August 1970). Final Report. Clark, J. C. (EG and G, Inc., Santa Barbara, Calif.). Nov 1970. Contract AT(29-1)-1183. 9p. Dep. NTIS.

The organic dye laser technology has been investigated for its suitability as a high-power optical carrier for nuclear data telemetry. The laser characteristic desired is a smooth single pulse of 10 to 50 μsec duration with a peak power of several kilowatts. Tests of various organic-dye solutions performed with both linear and helical flash-lamp pump configurations have demonstrated the capability of the dye laser to provide the desired performance as well as serve as a useful tool in nuclear diagnostic applications such as data transmission during nuclear test events. (auth)

32302 (EGG-1183-2263) HIGH-POWER OPTICAL CARRIER FOR NUCLEAR DATA TRANSMISSION. Excerpt from AEC R and D Final Report, No. EGG-1183-2187, S-430-R, Published August 1968. Final Report. No. S-433-R. Clark, J. C. (EG and G, Inc., Goleta, Calif.). Aug 1968. Contract AT(29-1)-1183. 11p. Dep. NTIS.

Several techniques were investigated for generating an optical pulse of several kilowatts peak power and of a duration of several microseconds at a spectral wavelength suitable for detection by wide bandwidth photodiode detectors for long range optical transmission of weapons test data through the atmosphere. Of two techniques selected for detailed experimental investigation, the scheme employing a passive nonlinear threshold absorber appeared promising. (auth)

32303 (INR-1236) EMITTER FOLLOWER TEMPERATURE STABILITY AND LINEARITY ANALYSIS. Bayer, R. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 30p. Dep. NTIS (U. S. Sales Only).

Although the emitter follower is widely used in electronic circuits of nuclear pulse spectroscopy, its extreme possibilities concerning linearity and temperature stability have not yet been analyzed. The analysis is done with the help of signal flow graphs. The advantages of the method are more pronounced when the sensitivity, stability, gain, input and output impedances are considered. The transistor is replaced with its hybrid-pi model. The results of the analysis are given. (auth)

32304 (NIM-967) AUTOMATIC TIMING OF THE NEUTRON-GENERATOR COUNTING STATION. Sellschop, J. P. F.; Uken, E.-A.; Steele, T. W.; Wall, G. J.; Hulse, N. D. (National Inst. for Metallurgy, Johannesburg (South Africa)). 7 Aug 1970. 10p. Dep. NTIS (U. S. Sales Only).

A brief account is given of the design and construction of an automatic timing system for the simultaneous radiometric measurement of an unknown sample (in analyzer live-time) and a reference standard (in clock time). (auth)

32305 METHOD AND APPARATUS FOR MARKING CASED CONTAINERS BY RADIATION OF SENSITIVE EMULSIONS. Petersen, Russell E.; Crowe, John W. U. S. Patent 3,560,745. 2 Feb 1971. Filed 26 Apr 1966.

A radiation-sensitive emulsion is applied to an end of each container prior to packing in a shipping carton. After storage and without removing the containers from the carton, x rays or gamma rays are passed through a shield formed with apertures to expose on the emulsion of each container desired indicia, such as price symbols. Thus, canned goods may be warehoused in shipping cartons and then price-marked prior to shipment from the warehouse without uncasing the cans and without the necessity of the retail clerks price-marking individual cans. (auth)

32306 SUBNANOSECOND RISETIME FLUXMETER. Pellinen, D. G. (Physics International Co., San Leandro, Calif.). Rev. Sci. Instrum.; 42: 667-70(May 1971).

A self-integrating search coil with a risetime of approximately 0.4 nsec has been developed for measuring kilogauss magnetic fields in adverse environments. A coaxial calibration fixture with a field risetime of 0.85 nsec was built to calibrate the fluxmeters. (auth)

32307 FIELD MEASUREMENTS IN A SPLIT-POLE SPECTROGRAPH. Zu Bentheim, F.; David, P.; Debrus, J.; (and others) (Univ., Bonn). Nucl. Instrum. Methods; 93: No. 1, 29-33(1971).

The differential field inhomogeneity of the larger magnet of a split-pole spectrograph has been measured with NMR probes at 3, 5, 7, 9, 11, 14, 16 and 17 kG. The fringing field was also investigated at 3, 5, 7, 9, 13 and 16 kG, using a Hall probe. The fringing-field distributions were parameterized and corresponding coefficients are given. The results depend on the speed used in setting the magnetic field. This effect which cannot be taken into account in numerical field calculations is discussed. (auth)

32308 APPROXIMATION AND ACCURACY IN THE DESIGN OF A DOUBLE-FOCUSING FLAT SPECTROMETER. Besev, C.; Castman, B.; Groth, T. (Univ. of Uppsala). Nucl. Instrum. Methods; 93: No. 1, 17-27(1971).

The problem of calculating accurate magnetic fields from a configuration of air-cored coils was systematically investigated by using current-sheets, current-loops and extended coils as approximations of the real coils of an existing well-established iron-free double-focusing spectrometer. The relative goodness of the various approximations was judged on the basis of isoaberration contours as calculated in the corresponding magnetic fields. The influence of constructional errors on the quality of the spectrometer was investigated by adding random errors to the physical parameters of the coils. The corresponding effect on the transmission-resolution characteristics was illustrated. The disturbing effect of magnetic fields from outside was also investigated. The choice of a proper model for the field calculation was made in view of the effect of plausible constructional errors. (auth)

32309 RANDOM PULSE-BURST GENERATOR FOR SIMULATION OF GAUSSIAN DISTRIBUTION. Halling, H.; Kreiger, E. (Reaktorzentrum-Seibersdorf, Vienna). Nucl. Instrum. Methods; 93: No. 1, 171-2(1971).

The unit delivers pulse bursts as well as 24 bit parallel digital numbers. These numbers are Gauss-distributed with independently adjustable mean value and variance. The mean value can be preselected from 0 to 2×10^7, the maximum deviation can be up to $\pm 10^6$. (auth)

32310 DEAD-TIME CORRECTION IN MULTICHANNEL ANALYZERS. Simmer, J. (Lab. of Algology, Trebon, Czech.). Nucl. Instrum. Methods; 93: No. 1, 131-2(1971).

An equation presented in Nucl. Instr. and Meth. 78(1970) p. 80 for the deadtime effect in multichannel analyzers is corrected. (W.H.K.)

32311 TEMPORAL AND RANDOM APPROACHES TO THE DEAD-TIME CORRECTION IN MULTICHANNEL ANALYZERS. Carloni, F.; Corberi, A.; Marseguerra, M.; Porceddu, C. M. (CNEN, Bologna). Nucl. Instrum. Methods; 93: No. 1, 133-6 (1971).

Simmer's criticism (Nucl. Instr. and Meth. 93(1971) p.131) of a previous paper of the authors is refuted and offers the chance to structure the deadtime correction in a general scheme. Corrections are proposed with the aim of obtaining a higher degree of approximation. (auth)

32312 WEISSENBERG CAMERA ALIGNMENT DEVICE. Bretherton, L.; Kennard, C. H. L. (Univ. of Queensland, Brisbane). J. Phys., E (London); 4: 332-4(Apr 1971).

In order to prevent unnecessary x-ray exposure during the alignment of a Stoe Weissenberg camera, a safety device was made which acts as a protective cover linking the collimator of the camera with a see-through beam stop. (auth) (UK)

Radiation Effects on Instruments and Instrument Components

32313 (ORNL-4678) EFFECTS OF FAST NEUTRONS ON POLYCRYSTALLINE ALUMINA AND OTHER ELECTRICAL INSULATORS AT TEMPERATURES FROM 60° TO 1230°C. Keilholtz, G. W.; Moore, R. E.; Robertson, H. E. (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 109p. Dep. NTIS.

The effects of fast neutrons on four commercial polycrystalline alumina products of high density were investigated. These materials have been considered for use as electrical insulators in nuclear-powered thermionic converters. Fast-neutron fluences up to 5.8×10^{21} neutrons/cm^2 (>1 MeV) were achieved; irradiation temperatures ranged from 60 to 1230°C. At temperatures below 100°C, there was very little damage, as is usually manifested by gross fracturing, volume increase, and separation at grain boundaries. Damage was much worse, however, at temperatures from 570°C to 1070°C, which is the range of greatest interest for thermionic applications. At about 1100°C and above, in-reactor thermal annealing was rapid enough to reduce damage significantly, but at much higher temperatures (~1230°C), damage again increased. Based on the irradiation results, the following conclusions and recommendations were made for the use of polycrystalline alumina in thermionic converters: (1) the alumina should be of high purity to minimize gross fracturing, and it should be of small grain size to minimize the effects due to separation at grain boundaries, (2) the thermionic device should be designed for continuous operation because thermal cycling apparently promotes separation at grain boundaries, (3) the design should allow for an increase in volume of the alumina insulators of about 3%, and (4) alumina of high purity and small grain size can withstand fast neutron fluences up to about 3×10^{21} neutrons/cm^2 in an ETR type neutron spectrum and up to about 2×10^{21} neutrons/cm^2 in an EBR-II type spectrum for those neutrons with energies greater than 1 MeV. Four other electrical insulators were investigated in a preliminary manner as possible alternatives to polycrystalline alumina for thermionic applications. These are: (1) single-crystal Al_2O_3, (2) single-crystal MgO of high purity, (3) transparent polycrystalline Y_2O_3, and (4) silicon oxynitride (Si_2ON_2). The preliminary results were very encouraging. More comprehensive investigations of these materials appear to be warranted. (auth)

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LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstracts 31775 and 31777.

Basic Processes

Refer also to abstract 32409.

32314 RECENT SOIL, FERTILIZER AND PHYSIOLOGICAL STUDIES WITH ^{32}P ON HIGH YIELDING VARIETIES OF PADDY. Subbiah, B. V.; Katyal, J. C. (Indian Agricultural Research Inst., New Delhi). pp 61-81 of Isotopes and Radiation in Investigations of Fertilizer and Water Use Efficiency in Countries of Asia and the Far East. Vienna; International Atomic Energy Agency (1970). (CONF-690418-12).

From Use of isotopes and radiation in investigations of fertilizer and water use efficiency meeting; Bangkok, Thailand (21 Apr 1969).

A knowledge of the rooting pattern of high yielding paddy varieties is of considerable importance in soil, water and fertilizer management problems. Studies were carried out on the applicability of the ^{32}P plant injection technique for paddy, comparison of the results of root activity obtained by the placement of ^{32}P in different soil zones and root distribution pattern by ^{32}P plant injection technique, the root distribution pattern of some of the high yielding dwarf paddy varieties as compared to local ones, and effect of nitrogen fertilization on the rooting pattern of a dwarf variety. ^{32}P plant injection technique was found to be applicable for paddy for evaluation of root distribution and injecting ^{32}P into the plant with sucrose was found to result in increased transport of the activity from the stem to the roots. The root activity data by ^{32}P placement (in capsules) gave statistically reproducible results which are highly correlated with the root distribution pattern obtained by ^{32}P plant injection technique. The high yielding dwarf varieties (viz. IR-8 and Taichung Native I) were found to have more intensity of root distribution in lower depths as compared to local tall variety (viz. NP 130). Effect of increasing levels of nitrogen fertilization was found to result in a greater intensity of root distribution in lower depths. (auth)

32315 MEASUREMENT OF GLOMERULAR FILTRATION RATE USING A SINGLE INJECTION OF ^{51}Cr-EDETIC ACID. Bailey, R. R.; Rogers, T. G. H.; Tait, J. J. (Christchurch Hospital, N. Z.). Australas. Ann. Med.; 19: 255-8(1970).

A simple method of estimating the glomerular filtration rate using a single injection of ^{51}Cr-EDTA is described. The technique, which avoids urine collections, has been found to correlate well with the 24 hour endogenous creatinine clearance over a wide range of renal function. The complex is not attached to erythrocytes or significantly bound to plasma proteins. In non-oedematous patients equilibration in the body space is completed in under 2 hours, following which an exponential fall in plasma activity occurs. (auth)

32316 APPLICATION OF RADIOAUTOGRAPHIC TECHNIQUES IN DETERMINING THE TURNOVER OF CELL COMPONENTS. Larra, Francis; Droz, Bernard (CEA, Saclay, France). J. Microscop.; 9: 845-80(Nov 1970). (In French).

Radioautographic methods for studying hydrosoluble and liposoluble substances and macromolecular complexes are described. The techniques employed are discussed in detail and the validity of the results obtained, critically examined; the resolving power, quantitative estimation, sensitivity, and possible radiation damage are analyzed. The value of radioautography in studying cell turnover by identifying synthesis sites, and migration paths towards other cell compartments, is examined. The use of this method in studying the turnover of substances in a cell structure by analyzing the tracer decay curves is described. The distribution of the nuclear tracer in a given cell organelle is studied. (auth) (France)

32317 NORMAL AND DEFECTIVE REPAIR OF DAMAGED DNA IN HUMAN CELLS: A SENSITIVE ASSAY UTILIZING THE PHOTOLYSIS OF BROMODEOXYURIDINE. Regan, James D.; Setlow, R. B.; Ley, R. D. (Oak Ridge National Lab., Tenn. Univ. of Tennessee, Knoxville). Proc. Nat. Acad. Sci. U. S. A.; 68: 708-12(Apr 1971).

A new technique was developed for studying the extent of repair of uv radiation damage to DNA in human cells. It is easy to use, has excellent sensitivity, and provides rapid quantitative estimates of repair. Ultraviolet-irradiated cells whose DNA had been previously labeled with a radioisotope were grown after irradiation in nonradioactive bromodeoxyuridine, which was incorporated at the breaks induced by repair enzymes. After a period of growth in the thymidine analog the cells were exposed to a large flux of 313 nm radiation and then lysed on top of an alkaline sucrose gradient. Bromodeoxyuridine-containing sections of the DNA were thus selectively photolyzed. Sedimentation in the alkaline gradient revealed the average molecular weight of disrupted segments and gave a measure of the number of breaks induced by repair enzymes over the whole period allowed for repair. The large change in average molecular weight observed upon exposure of normal repairing cells to 313 nm radiation was not observed in the repair-deficient cells from patients with xeroderma pigmentosum. The quantitative aspects of this assay for repair and its sensitivity should make it applicable to the study of repair induced by agents other than uv radiation. (auth)

32318 STUDY OF CORONARY CIRCULATION BY MEANS OF ^{86}Rb. Di Matteo, Jean (Hospital Necker, Paris); Vacheron, Andre; Kellershohn, Claude; De Vernejoul, Pierre. Compt. Rend., Ser. D; 272: No. 2, 275-8(11 Jan 1971). (In French).

The coronary flow can be measured without cardiac catheterism by dilution curves using rubidium 86 and technetium 99m-labeled red blood cells. Forty-one subjects were examined. This study confirms the privileged nature of the coronary flow which protects the myocardium from oxygen starvation in the event of reduced systemic flow. It defines the homodynamic repercussions of coronary arteriosclerosis and demonstrates the development of a compensatory flow after a myocardial infarction. (France)

32319 METHOD FOR MEASURING THE NORMAL BLOOD VOLUME OF THE RAT USING [^{125}I]LABELLED ALBUMIN. Brooks, Sandra (Univ. of Melbourne). Aust. J. Exp. Biol. Med. Sci.; 49: No. 2, 241-3(Apr 1971).

A reliable method of estimating blood volume in the rat using [^{125}I]labeled albumin is described. In 16 normal animals the blood volume was found to be 5.59 ml/100 g body weight (±0.44 ml standard deviation). A standard error of ±0.11 ml in this technique is small and therefore should allow changes in blood volume due to pathological states to be accurately measured. (auth)

32320 DISTRIBUTION VOLUMES OF LABELLED RED BLOOD CELLS AND LABELLED PROTEIN AND F CELLS IN INTACT AND SPLENECTOMIZED HbA AND HbB TYPE SHEEP. Dooley, P. C.; Morris, R. J. H.; Harris, L. R. J. (Univ. of New England, Armidale, Australia). Aust. J. Exp. Biol. Med. Sci.; 49: No. 2, 129-44(Apr 1971).

The dilutions of ^{51}Cr-labeled red blood cells and ^{125}I-labeled albumin were studied over a 10 hour period in HbA and HbB sheep, both before and after splenectomy. The dilution curves were analyzed into exponentials, and values for red blood cell volume and plasma volume were calculated from various portions of the curves. Dilution curves for labeled red blood cells in intact sheep showed important differences from those in splenectomized sheep. Red blood cell volume was calculated from: the extrapolation of the exponential process with the slowest decay rate; the sum of intercepts of all exponential processes; jugular haematocrit and plasma volume. Splenectomy significantly reduced the values for these parameters. Plasma volume was calculated from the extrapolation of the exponential with the slowest decay rate and from the sum of intercepts of all exponential processes. Splenectomy significantly reduced the values for these parameters. Blood volume and the value for the ratio of body to jugular haematocrit were calculated from the data, and were found to be significantly reduced by splenectomy. Differences between HbA and HbB sheep were found only for jugular haematocrit and red blood cell volume calculated from jugular haematocrit and plasma volume. The differences in values from the several methods of calculating red blood cell volume in intact sheep and the reduction of these values by splenectomy are discussed in relation to the splenic red blood cell content. (auth)

32321 METHOD FOR MEASURING MINERALIZATION IN LAKE SEDIMENTS. Harrison, Michael J.; Wright, Richard T.; Morita, Richard Y. (Oregon State Univ., Corvallis). Appl. Microbiol.; 21: 698-702(Apr 1971).

A method is described for measuring the mineralization of an organic solute (^{14}C-glucose) by the heterotrophic indigenous bacteria in lake sediments. Since there is no suitable procedure for the determination of in situ microbial activities in sediments, the procedure described is probably the best devised so far and may serve as a base for a more definitive procedure. (auth)

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32322 CHANGE IN DYNAMICS OF AMINOTRANSPHERASE ACTIVITY IN BLOOD AND SKIN OF CALVES WITH UV RADIATION. Golovach, V. M.; Ratich, I. B. (Ukrainian Research Inst. of Physiology and Biochemistry of Domestic Animals, Lvov). Ukr. Biokhim. Zh.; 42: 775-8(1970). (In Ukrainian).

The effects of uv radiation on aminotransferase activity (aspartate-aminotransferase and alanine-aminotransferase) in blood serum and skin of calves were studied in dynamics. Material for the investigation was taken before irradiation and 6, 12, and 24 hrs after irradiation. It was established that irradiation of animals with lamps "ПРК-2" for 25 min results in an increase in aminotransferase activity. For aspartate-aminotransferase it was mostly expressed 6 and 24 hr after irradiation, and for alanine-aminotransferase, 6 and 24 hr later. Activity of the investigated aminotransferases in blood serum in dynamics did not change and was approximately the same as before irradiation. (auth)

32323 RADIOISOTOPE TECHNIQUE FOR THE MEASUREMENT AND TREATMENT PROCESS MODELLING OF BIOLOGICAL SLIMES USED IN WASTE TREATMENT. Reid, G. W. (Univ. of Oklahoma, Norman). pp 749-54 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

An apparatus that models reaction rates of biological slimes and algae responsible for the reduction of organic pollutants, as well as nutrients related to eutrophication was developed. The reaction coefficients are traced using ^{32}P. The apparatus traces ^{32}P uptake as a function of time, depicting assimilation rather than respiration as in the Warburg and other techniques. The model takes the form of $dy/dt = -k(L - y)$, where L is the impressed load, y the uptake, t the time, and k the reaction coefficient. Alterations in k are noted relative to environmental conditions such as temperature, toxic agents, and waste concentration. The model is also responsive to slug and completely mixed systems. More specifically, the biological slime is grown on a rotating drum. The drum rotates through the substrate (sewage) containing ^{32}P and after passing through liquid environment and tracer, the attached slime is counted. Log percentage uptake of ^{32}P plotted against time provides (the slope) values of the reaction-rate coefficients which are used to evaluate the environmental effects on the biosystem. The apparatus has been fully tested, was constructed very economically and uses quantities of radioisotopes that are exempt from USAEC licensing. In addition to studying the effects of the wastes on the biokinetics of treatment plant design, it is useful in detecting absolute values of slime and algae uptake or radioisotopes, e.g., monitoring pollution. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 32376, 32392–32394, 32396, 32402, 32403, 32405, 32406, 32410–32412, 32448, 32449, 32453, 32455, 32466, 32469, 32503, 32526, 32530, 32565, and 32617.

32324 (UCLA-12-814) RAPID UPTAKE OF 1-^{14}C ACETATE BY THE ADULT RAT BRAIN 15 SECONDS AFTER CAROTID INJECTION. Dhopeshwarkar, G. A.; Subramanian, Carole; Mead, James F. (California Univ., Los Angeles). [1971]. Contract AT(04-1)-Gen-12. 16p. Dep. NTIS.

Carbon-14-labeled acetate was injected into the carotid artery of adult rats followed by decapitation after 15 seconds. Brain, liver and blood lipids were extracted. Analysis of the lipids showed that there was considerably more uptake of radioactivity in the brain as compared to the liver or the plasma. High radioactivity in the cholesterol fraction was found indicating rapid synthesis from radioactive acetate. Incorporation of radioactivity into all major polar lipid fractions of the brain lipids occurred including sphingomyelin and cerebrosides, considered to be myelin lipids. PS was the most highly labeled component. Palmitic acid isolated from the brain was synthesized de novo from acetate and stearic acid was formed by chain elongation. All these metabolic reactions occurring so rapidly in the brain are discussed in view of the older concept that adult brain is a tissue characterized by slow metabolism. (auth)

32325 (UCRL-72511(Rev.1)) FATE OF SCHOONER FALLOUT RADIONUCLIDES INGESTED BY THE DAIRY COW. Potter, G. D.; Vattuone, G. M.; McIntyre, D. R. (California Univ., Livermore. Lawrence Radiation Lab.). 22 Feb 1971. 22p. (CONF-701102-19). Dep. NTIS.

From Meeting of the American Nuclear Society; Washington, D. C. (15 Nov 1970).

Debris from the Schooner Event, a Plowshare nuclear cratering experiment, was fed to a lactating cow and to a pregnant cow. Milk, urine, feces and plasma levels of individual gamma-emitting radionuclides were followed for six days in these cows. In addition, the radionuclides in the maternal and fetal tissues of this pregnant cow were studied. Radionuclides of tungsten, iodine, tellurium, barium and rhenium were observed in milk. Those of arsenic, ruthenium, iodine, tellurium, tungsten and rhenium were observed in urine. Maternal and fetal tissues contained radionuclides of iodine, barium and tungsten, while maternal tissues contained these and radioarsenic as well. (auth)

32326 COMPARATIVE METABOLISM OF RADIONUCLIDES IN MAMMALS: A REVIEW. Stara, J. F. (Public Health Service, Cincinnati); Nelson, N. S.; Della Rosa, R. J.; Bustad, L. K. Health Phys.; 20: 113-37(Feb 1971).

An extensive review of animal and human metabolism data for selected radionuclides is presented in an attempt to assess the value of animal research and subsequent extrapolation of the results to man. Since isotopes of related elements generally follow similar metabolic pathways, radionuclides of biological importance were selected and grouped by their respective chemical families. Criteria for selection included world-wide atmospheric contamination, general use in medicine and industry, contribution to the natural radiation environment, and their radiotoxicity. In this review, reported results, supplemented by original work, were compiled for the following radionuclides: ^{137}Cs for the alkali metals; ^{90}Sr and ^{226}Ra for the alkaline earths; ^{65}Zn; ^{239}Pu for the lanthanides and actinides; ^{131}I for the halides; ^{210}Po and ^{210}Pb for the transitional elements; and ^{106}Ru for the transition metals. An appraisal of biological effects and of therapeutic or preventive methods for each radionuclide is also given. (201 refs.) (auth) (UK)

32327 THYROIDAL RADIOIODINE UPTAKE VALUES IN EUTHYROID SUBJECTS IN THE MONTREAL REGION. Vitye, B.; Brouillet, J. (Hotel-Dieu Hospital, Montreal). Union Med. Can.; 100: 257-8(Feb 1971). (In French).

The 24 hour radioiodine uptake values were determined in 31 healthy volunteers and in 212 euthyroid patients. The values found were considerably lower than those generally reported in the literature. These low values in our region are not due to a new process of bread manufacturing as reported for the Birmingham area. Furthermore the present study underlines the necessity to evaluate periodically the normal values for thyroidal radioiodine uptake on a regional basis. (auth) (Canada)

32328 USE OF RADIOISOTOPE TECHNIQUES FOR DETERMINING THE WEANING PERIOD IN EXPERIMENTAL ANIMALS. Babicky, A.; Ostadalova, I.; Parizek, J.; Kolar, J.; Bibr, B. (Institutes for Biological Research, Prague. Charles Univ., Prague). Physiol. Bohemoslov.; 19: 457-67(1970).

Strontium radioisotope (^{85}Sr) was administered to female rats at different intervals after littering and ^{85}Sr retention in the maternal organism and its intake in the suckled young were determined 24 and 48 hours after injection by means of a whole-body counter. Maximum strontium intake by the young, at both intervals, was found when the isotope was administered to the lactating females during the third week after littering. When administered earlier or later, the values were lower. After the maximum, strontium intake by the young fell up to the end of the fourth week after birth, when the radioactivity values found in the young virtually excluded the possibility of ^{85}Sr transfer in maternal milk. The results of whole-body measurements were fully borne out by the results of determination of the ^{85}Sr content of the tibiae of the same young. Strontium retention by the lactating females (at 24 and 48 hours) was markedly lower than in the controls of the same age and during lactation it fell up to the end of the third week after littering. During the four weeks it steadily rose again and the values in the experimental females a few days after lactation stopped exceeded those in the controls of the same age. As seen from a time analysis of the above changes and from the sum of the values in the females and the young the lowered strontium retention found in lactating females during the first two postnatal decades could not be attributed to strontium release into maternal milk only. It must therefore be presumed that in these animals strontium was excreted by some other route. In experiments in which a laboratory diet homogeneously labeled with ^{131}Ba in the form of $BaSO_4$ was employed, it was found that the suckled young took no solid food during the first 14 days of postnatal life. From the 16th day they displayed signs of an increasing intake of solid food. The use of radioisotope techniques thus made it possible to determine the length of the weaning period. Under the given experimental conditions, this period starts during the first days of the third postnatal week, when the young first take solid food, and terminates at the end of the fourth postnatal week, when the

young stop taking maternal milk. In the course of the weaning period, i.e., during the third and fourth week after birth, the ratio of the nutrients taken in the form of maternal milk and the laboratory diet gradually alters. On the basis of these findings and of other experiments using prolonged lactation or premature, forcible weaning, the physiological mechanisms regulating weaning and the significance of adaptation processes associated with weaning for the young and the female are discussed. (auth)

32329 ROLE OF PLANKTON IN THE BEHAVIOR OF ^{99}Tc AND ^{54}Mn IN SEAWATER. Tikhomirov, V. N.; Gromov, V. V.; Bernovskaya, R. N.; Spitsyn, Vikt. I. (Inst. of Physical Chemistry, Moscow). Dokl. Akad. Nauk SSSR; 194: 445-7(11 Sep 1970). (In Russian).

As part of the investigation of the accumulation of microelements in seawater and their migration in the ocean, the behavior of ^{99}Tc and ^{54}Mn was studied. The study was carried out in the Pacific during the 46th trip of the research ship "Viteaz". Plankton was collected from a depth between the surface and 30 m, diluting the collected material with seawater at the rate of 0.06 g per liter of water. One of the studied radioisotopes was then added to the water containing the plankton. The tests were carried out in three parallel series determining the uptake of the element during biosynthesis of the bacteria in darkness, and comparing their general behavior with and without addition of 10 μg/l of Fe^{3+}. The tests revealed that both elements are adsorbed by the plankton. ^{99}Tc was taken up primarily by the phytoplankton and to a lesser extent by the zooplankton. The presence of iron enhanced the process, probably as a result of the products of iron hydrolysis. The absence of photosynthesis in the darkness reduced the amount of the uptake of the isotopes, especially of ^{54}Mn by the plankton. Both isotopes formed colloidal solutions with particle sizes of >0.1 μ consisting of the fecal matter of the plankton. (TTT)

32330 COMBINED USE OF ION EXCHANGE RESINS AND OSMOTIC DIURESIS FOR THE DECREASE OF ^{85}Sr CONCENTRATION IN THE ORGANISM. Nikolov, Iv.; Bokova, N.; Kiradzhiev, G. Rentgenol. Radiol.; 9: No. 2, 87-92(1970). (In Bulgarian).

Investigations were carried out with rats receiving ^{85}Sr per os and treated with ion exchange resins (Dowex-50Wx2, Amberlit-IRC-50) and manetol. The preparations were given alone or in combination at varying intervals after the application of the radioactive substance. Superior results were obtained with the use of ion exchange resins alone, administered 10 and 30 minutes after strontium. In using these preparations in combination with manetol (to induce osmotic diuresis) the effectiveness of decorporation was reduced. The use of manetol alone failed to reduce ^{85}Sr adsorption. The effective period of half-elimination was shortened in the interval from 2 to 72 hours with the use of ion exchange resins alone. (Abstr. Bulg. Sci. Med. Lit.)

32331 ^{90}Sr IN HUMAN TEETH. PART III. Keil, R.; Randow, F.; Schulze, H.-A.; Koine, R. (Univ., Rostock, Ger.). Strahlentherapie; 140: 442-7(Oct 1970). (In German).

The methodology and results concerning the ^{90}Sr content of deciduous teeth, collected in the region of Rostock between 1956 and 1963, are reported. For each year, the following value was obtained in Strontium units: 1.5 (1956), 1.7 (1957), 2.0 (1958), 2.2 (1959), 2.3 (1960), 2.4 (1961), 4.6 (1962), 4.4 (1963). In comparing these results with those published in literature, the following problems are discussed: stability of the relation between the ^{90}Sr content of the teeth and of the skeletal bone; the possibility of any modification of the ^{90}Sr content in the teeth after final calcification; the difference in contamination of the intact and of the carious teeth; and which type of teeth, deciduous or permanent ones, is the best test object. (auth)

32332 PROBLEMS OF EXCRETION ANALYSIS OF ^{210}Po IN URANIUM MINERS. Hoelgye, Zoltan (Institut fuer Arbeitshygiene, Pribram, Czech.). Strahlentherapie; 140: 573-6(Nov 1970). (In German).

Because of the reduction of radon concentration in uranium mines to values of 10^{-11} to 10^{-9} Ci Rn/l, the portion of ^{210}Po (manifesting from this source in the urine) has become so little that ^{210}Po derived from mine dust and the natural ground can no longer be neglected. It was assumed that the diminuation of ^{210}Po excretion in the urine was influenced by the losses of polonium which is stored in the bone, as well as by the excretion of ^{210}Bi. The supposition mentioned was based on the results of the examination of ^{210}Po in the urine of workers in uranium mines in Czechoslovakia. (auth)

32333 ACCUMULATION AND DISTRIBUTION OF THE GLOBAL ^{90}Sr IN THE SKELETON OF LEUKEMIC AND NON-LEUKEMIC COWS. Shindel'man, Yu. M. (National Latvian Veterinary Lab., Riga). Latv. PSR Zinat. Akad. Vestis, No. 2, 63-7(1971). (In Russian).

Accumulation of ^{90}Sr in skeletons of cows depends on the soil and climatic conditions of farms. The ratio between the radioactivities of skeletons at different farms reaches the factor of three (1968). Skeletal distribution of ^{90}Sr in cows varies both in different bones and also within any single bone. Metacarpal diaphyses and epiphyses, and coccygeal vertebrae were investigated, and the highest level of ^{90}Sr was found in metacarpal diaphysis while the lowest was established in the coccygeal vertebrae. No significant difference was observed between accumulation and distribution of ^{90}Sr in leukemic, reticulose and nonleukemic cows. Only a slight trend to greater accumulation of ^{90}Sr in bones of reticulose cows was marked. (auth)

32334 DETERMINATION OF THE CONTENT OF PLUTONIUM IN THE HUMAN ORGANISM BY THE RATE OF ITS ELIMINATION. Osanov, D. P.; Tissen, M. Yu.; Filatov, V. V. Med. Radiol.; 14: No. 4, 44-51(Apr 1971). (In Russian).

A model was used for determining the transport of inhaled plutonium in the body and relations between the contents of plutonium in various organs and in the entire body as well as the urinary excretion. This correlation as a function of time was obtained for different regimens of plutonium aerosol administration with diverse degrees of dispersion and solubility. Results are presented in the form of graphs and may be utilized for assessing the plutonium content of the organism following single and repeated doses. (auth)

32335 EXPERIMENTS ON THE DISTRIBUTION OF ^{86}Rb. Moskalev, Yu. I.; Kulikova, V. G.; Rogacheva, S. A. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 3-22(1970). (In Russian).

Rubidium-86 is relatively evenly distributed in the tissues and organs of animals in a manner that is independent of weight, dose, and method of introduction. The highest concentrations, during the period immediately following introduction, were observed in the kidneys (3.37%), heart (3.15%), thyroid gland (2.98%), submaxillary gland and small intestine (about 2.54%), blood (0.16%), and brain (0.04%). As a result of the accumulation of Rb in some organs (brain, testes, spleen, blood, muscles, and bone marrow), and its distribution to others (kidneys, heart, stomach, large and small intestine, salivery glands, lungs, adrenal gland, and thyroid gland), the content of the different organs approaches uniformity within 2 to 4 days following the introduction of the radioisotope. Following intravenous injection, ^{86}Rb is rapidly removed from the blood vessels; within 5 min only 1.66% of the amount introduced remains. Subsequently, up to the 4th day, there is seen a gradual increase in its content up to 4.16%. Circulating in the blood, the ^{86}Rb is contained almost exclusively in the formed elements of the blood (5 to 10 times higher than in plasma). The highest quantities of ^{86}Rb retained in tissues were found in muscles (up to 67.6%), liver (up to 10.8%), skin (up to 9.6%), kidneys (up to 7.17%), and skeleton (up to 7.0%). Excretion of ^{86}Rb in the urine and feces amounts to about 32.8% following injection of 0.075 mg. Excretion is primarily in the urine, fecal excretion accounting for only 5 to 6% of the total amount. (tr-auth)

32336 DISTRIBUTION OF ^{228}Ac FOLLOWING INTRAVENOUS INJECTION. Timofeeva-Resovskaya, E. A.; Moskalev, Yu. I.; Born, G. I. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 23-30(1970). (In Russian).

Uptake and distribution studies of ^{228}Ac ($MsTh_2$) in mice and rats showed that, following intravenous and subcutaneous introduction, the largest quantities of the isotope were found in the liver, bones, and kidneys of the examined animals. The concentration of actinium radioisotope activity in liver was found to be 5 to 10 times higher than in the bones, kidneys, spleen, and adrenal glands, and twice as high as in other organs studied. The elimination of actinium from the blood of mice was slower than in rats. Also, tissue distribution of the actinium in mice was considerably slower. Skeletal uptake of ^{228}Ac following subcutaneous injection was higher than was the case following intravenous injection. (R.V.J.)

32337 DISTRIBUTION OF ^{224}Ra FOLLOWING INTRAVENOUS INJECTION. Moskalev, Yu. I.; Strel'tsova, V. N. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 31-9(1970). (In Russian).

Following intravenous injection into rats, Th-X Radium-224 was inhomogeneously distributed, the highest accumulations occurring in bones. The largest accumulations in soft tissues during early post-injection times occurred in the kidneys, salivary glands, thyroid gland, intestinal mucosa, and stomach. The glandular mucosa of the stomach contained significantly larger quantities of Th-X than did the intestinal mucosa. The diaphysis

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of bones contained less Th-X than did the epiphysis. Most of the Th-X that was excreted, was excreted during the first day following injection, after which the rate of excretion decreased significantly. The total excretion (urine and feces) for a 7 to 13 day period was 32 to 43% of the amount injected. Young rats excreted less Th-X than adults. The ratio of urinary to fecal excretion for young rats was also less than for adult rats, evidence of the fact that gastrointestinal excretion in young rats was more intense than in the adult rats. (tr-auth)

32338 TRANSFER OF RADIOISOTOPES FROM MOTHER TO FETUS. Kulikova, V. G. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 55-61(1970). (In Russian).

It was established that the radioisotopes ^{32}P, ^{45}Ca, ^{54}Mn, ^{59}Fe, ^{60}Co, ^{65}Zn, ^{86}Rb, ^{90}Sr, ^{91}Y, ^{106}Ru, ^{115m}Cd, ^{131}I, ^{137}Cs, and ^{144}Ce migrate in large quantities into the fetus across the placenta, and are also secreted in the milk, if they are introduced into the body of the mother in the second half and especially during the last days of pregnancy. Based on the magnitude of the over-all secretion from the maternal animal (across the placenta during pregnancy and in the milk during the first 10 days of lactation), all of the radioisotopes are disposed of according to the following sequence: Sr > Ca > P > Mn > Zn; Fe > Rb > Cs > Co; Y > I > Ce > Ru > Cd. Based on the extent of uptake by the fetus during the second half of pregnancy, and on the magnitude of secretion in milk during the first ten days of lactation, the sequence is as follows: P > Ca; Zn; Sr; Mn; Cs > Rb > Fe > Y > I > Ce > Co > Cd. Virtually no Ru is secreted in the milk. (tr-auth)

32339 EFFECT OF EDTA, DDTE, AND DTPA ON THE BEHAVIOR OF ^{54}Mn IN ORGANISMS. Sukhacheva, E. I.; Tregubenko, I. P.; Semenov, D. I. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 62-4 (1970). (In Russian).

The effect of the early administration of a combination of EDTA, DDTE, and DTPA on the behavior of ^{54}Mn in rats following intravenous injection was studied. The combination reduced the deposition of the radioisotope in tissues and organs, increased significantly its excretion in urine, and reduced only slightly its excretion in feces. A correlation was observed between the efficiency of the combination and the constant for the displacement of calcium ions by manganese ions. The result was the formation of a complex between the manganese and the EDTA, DDTE, and DTPA combination. (tr-auth)

32340 EFFECTS OF EDTA, CHTA, AND DTPA ON THE BEHAVIOR OF ^{115}Cd IN THE BODY. Tregubenko, I. P.; Sukhacheva, E. I.; Belova, M. N.; (and others). Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 65-7(1970). (In Russian).

The behavior of cadmium complexes prepared with EDTA, CHTA, and DTPA in the body of animals was studied. The effects of early and late applications of these chelating agents on cadmium deposition in tissues and on its removal from the body following intravenous injection of about 0.3 mg in rats was also studied. The Cd-EDTA complex was partially decomposed under the conditions encountered in the body, while the Cd-CHTA and Cd-DTPA complexes, possessing higher stability constants, were almost completely excreted from the body during the first days. The application of the chelating agents at a remote time in reference to the introduction of Cd yielded no noticeable effects on deposition or excretion. Stable complexes with ^{115m}Cd were excreted almost entirely through the kidneys, part of the emitter being retained there (23 to 48% retained in the body). This latter finding enables the isotope complex to be used for irradiation of kidney tumors. (tr-auth)

32341 THREE COMPARTMENT MODEL OF THE PROCESSES OF SORPTION OF RADIOACTIVE Sr AND Y BY BONE IN VIVO. Bezel, B. S.; Tregubenko, I. P.; Gushchin, V. M.; Sukhacheva, E. I. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 104-10(1970). (In Russian).

Two possible variants were considered of a three compartment biological model based on a system of first order linear differential equations. The experimental confirmation of the model was conducted using a single intravenous injection of a $^{90}Sr-^{90}Y$ solution into rats. The applicability of both variants of the model for describing bone sorption and the removal of radioactivity from systems (blood and soft tissues) of rats during a 24-hr period following injection was shown. On the basis of calculations, it was determined that the short-term exchangeable skeletal radioactivity due to ^{90}Y was twice as great as that for ^{90}Sr. The value of the coefficient k_3, which determines the rate of removal of radioactivity from the exchangeable portions of the skeleton, did not depend upon the type of isotope nor on the variant of the model used. (tr-auth)

32342 INVESTIGATION OF THE INITIAL STAGES OF THE DEPOSITION OF OSTEOTROPIC RADIOISOTOPES. Lyubashevskii, N. M. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 111-18(1970). (In Russian).

Mucopolysaccharide complexes of the basic substance of bone tissue serve as intermediates between the blood and other physicochemical components of bone. A change in the properties of the basic substance, especially in its dynamic load of calcium or tetracycline, can sharply decrease the permeability of the skeleton for osteotropic radioisotopes. A combination of histochemistry, histoautoradiography, perfusion of the test preparations of bone, and the use of the continuous drop introduction of osteotropic radioisotopes used simultaneously with the in vivo recording of the dynamics of radioactivity of the bones and other tissues can be useful in the study of the physiology and pathology of bone tissue exchange. (tr-auth)

32343 BRAIN PATHOLOGY AND REGIONAL CEREBRAL OXYGEN UTILIZATION. Ter-Pogossian, Michel M. (Washington Univ., St. Louis). pp 358-64 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Regional cerebral blood flow was measured by means of water labeled with ^{15}O. Approximately 2cc of the patient's blood labeled with radioactive water was rapidly injected into the internal carotid. Approximately 1 mCi of labeled water was injected and the washout of this indicator was followed by a series of highly shielded probes placed over the skull. After the injection of the labeled water, a sample of the patient's blood with its hemoglobin labeled with radioactive ^{15}O was injected, and similar measurements made. The methods for analyzing and plotting the wash-out curves are given. These methods were used to determine the regional cerebral blood flow, regional oxygen utilization, and the compartment sizes for a series of normal subjects and subjects with demonstrated cerebral pathology. No appreciable difference in oxygen metabolism was found between either groups of subjects. It did appear, however, that pathology reduced the fast component portion of blood flow more than the slower fraction. (E.E.H.)

32344 SYNTHESIS OF RADIOPHOSPHORUS-LABELED DIPINE AND ITS DISTRIBUTION IN THE ORGANISM. Singin, A. S.; Suskova, V. S.; Serebryakov, N. G.; Safonova, T. S.; Chernov, V. A. (Inst. of Medical Radiology, Moscow. All-Union Scientific-Research Chemical and Pharmaceutical Inst., Moscow). Med. Radiol.; 15: No. 12, 31-4(Dec 1970). (In Russian).

The synthesis of ^{32}P-labeled dipine and its identification by means of thin-layer chromatography with autoradiography is described. The behavior of the preparation in control rats and those with transplanted sarcoma-45 was studied. The greatest radioactivity was found in the reticulo-endothelial system and kidneys. No accumulation in the neoplastic tissue was noted. The preparation was rapidly eliminated from the organism through the urine and to a lesser degree, through the gastrointestinal tract. (auth)

32345 REGULARITIES OF DISTRIBUTION OF RADIOACTIVE RARE-EARTH ELEMENTS. Stepanov, V. S.; Moskalev, Yu. I.; Zalikin, G. A. Med. Radiol.; 15: No. 12, 47-57(Dec 1970). (In Russian).

A brief review is given on the laws of rare earth element distribution in the organisms of mammals. Observations showed that simple salts of rare earth isotopes (^{140}La, ^{144}Ce-^{141}Ce, ^{147}Nd, ^{147}Pm, ^{153}Sm, ^{152}Eu, ^{170}Tm, ^{160}Tb, ^{46}Sc, and ^{91}Y), following intravenous injection, leave the blood very rapidly and are absorbed by the basic organs (skeleton, liver, and kidneys). With an increase in atomic weight of the element the amount of deposition increased in the skeleton and diminished in the liver. The rare earth nuclides were absorbed by the reticuloendothelial system (liver, spleen, and bone marrow) and to a lesser degree by the skeleton and kidneys. The excretion of rare earth isotopes was mainly through the intestinal tract. Isotopes were not absorbed from the intestinal tract and from the subcritical cells and were absorbed slowly and incompletely by the muscle tissues. The rare earth nuclides introduced by inhalation were very slowly absorbed by the lung tissue. Uptake of rare earth elements by the injured tissue took place mainly during the initial few hours after coming into contact with the skin. It was concluded that the distribution of the radioactive elements in the organism of mammals does not depend on the means of introduction and are mainly absorbed by the skeleton liver and kidneys. (R.V.J.)

32346 DISTRIBUTION OF ^{6}Li IN THE HEALTHY RATS AND IN RATS WITH WALKER-256 CARCINOSARCOMA. Letov, V. N.; Ivanov, V. N.; Ryabukhin, Yu. S.; Uspenskii, V. A.; Gorvat, F. Yu.

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(Inst. of Medical Radiology, Moscow). Med. Radiol.; 15: No. 12, 12-17(Dec 1970). (In Russian).

The distribution of ^{6}Li in the blood plasma, muscles, liver, kidneys, and lungs of Wistar rats without tumor and with subcutaneously transplanted Walker-256 carcinosarcoma (WCS-256) 3, 4, 6, 8, and 10 hrs after intraperitoneal injection of a 3% solution of lithium chloride was studied. A maximal accumulation in about 4 hrs was noted in all tissues and organs with the exception of the tumor. The greatest concentration of ^{6}Li was noted in the kidneys and lungs, the least in the liver. WCS-256 in the referred time interval produced no marked capacity to the selective inclusion of ^{6}Li. Lithium-6 concentration in the tumor was close to that in the blood plasma. The presence of WCS-256 decelerated processes of inclusion and elimination of ^{6}Li in organs and tissues. The data are of interest from the viewpoint of neutron-capture therapy with the use of ^{6}Li. (auth)

32347 WATER EXCHANGE OF TRITIUM OXIDE IN THE BRAIN AND SOME PERIPHERAL ORGANS OF RABBITS. Sanikidze, V. D.; Romanovskaya, L. L. (Inst. of Medical Radiology, Moscow). Med. Radiol.; 15: No. 12, 18-20(Dec 1970). (In Russian).

Data concerning experimental studies on tritium oxide exchange in some organs of rabbits 5, 10, 15, 20, 25, 30, and 60 min after intravenous injection of the isotope are reported. The dynamics of tritium oxide exchange after intravenous injection are of a periodical nature. The period of changes of the specific activity comprised 10 min. Periodical changes of the specific activity of the blood fluid of the head were in antiphase with that of the cerebral fluid. Balancing of the concentration of tritium oxide in the fluid of the organs studied occurred on the 25th to 30th min. (auth)

32348 HYPOTHYROSIS AFTER RADIOIODINE TREATMENT OF THYROTOXICOSIS. Chebotareva, E. D.; Livergrant, Yu. E.; Suslina, N. G.; Markova, O. P.; Bulbakh, V. D. (Inst. of Medical Radiology, Kharkov). Med. Radiol.; 16: No. 3, 28-33(Mar 1971). (In Russian).

The after effects of ^{131}I treatment of 1048 patients with thyrotoxicosis were analyzed. In 11% of the cases, hypothyrosis was found, increasing in incidence with increased time after therapy. The iodine absorption function of the normal thyroid gland decreased with age. A combination of electrophysiological radiodiagnostic methods is proposed for the diagnosis of early and atypical forms of hypothyrosis. A number of changes of the nervous, cardiovascular, excretory, and hematopoietic systems, and cholesterol metabolism associated with hormonal insufficiency in the thyroid gland and not with ^{131}I therapy or strumectomy were observed. (E.E.H.)

32349 STUDIES OF THE CONTENT OF ^{90}Sr IN MILK IN VARIOUS REGIONS. Rossi, Luigi; Rossi, Cesare; Maroccia, Ettore. Ann. Ist. Super. Sanita; 6: 316-17(1970). (In Italian).

Data are given on the level of contamination by ^{90}Sr considering altitude and climatic conditions of a particular region. The levels of radioactive ^{90}Sr in milk specimens taken in Cortina (1550 m), Belluno (370 m), and Rome (sea level) in 1966, 1967, 1968, and 1969 were compared. (R.V.J.)

32350 RADIOTRACER TECHNIQUE FOR THE STUDY IN VIVO OF THE BIOLOGICAL PATHWAY OF HEAVY METALS IN AQUATIC ORGANISMS. Girardi, F.; Merlini, Margaret; Bigliocca, Carla; Pozzi, G.; Berg, A. (EURATOM-CCR, Ispra, Italy). pp 721-33 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

While whole-body counting in vivo permits a study of the accumulation tracer radioisotopes in the whole animal, it is necessary to sacrifice many specimens at various intervals of time in order to establish the rates of uptake and final concentrations in the various organs and tissues of the organism. The possibility of direct in vivo measurements of the radioactivity of specific organs by means of a collimated detector is discussed. With this method it is possible to investigate the dynamic biological pathway of the pollutant during the absorption process in a single organism. The system, which is still in the developmental stage, is designed both to determine complete radioactivity mapping in the whole animal and at discrete points. It can be coupled with an automated gamma-ray spectrometer for multi-tracer experiments. Fast data analysis is made possible by direct connection with an IBM 360/65 computer. The system is described and data on its performances is given. Preliminary results obtained in practical applications to freshwater organisms using ^{203}Hg as a tracer for studies of Hg uptake by fish are reported. (auth)

32351 HAND RADIOACTIVITY AFTER INTRAVENOUS INJECTION OF ^{47}Ca: EFFECT OF AGE AND FEMORAL NECK FRACTURE. Arman, Eva (Karolinska Hospital, Stockholm). Geriatrics; 26: No. 3, 150; 156-7; 160-1; 164-5(Mar 1971).

A new method for estimating skeletal uptake of calcium is described. After an intravenous injection of ^{47}Ca the hand radioactivity is measured in a whole-body counter. Twenty-two controls and 10 patients with femoral neck fractures were studied. The hand uptake of ^{47}Ca was significantly lower in young controls than in elderly ones. Fracture patients had a significantly lower hand uptake in ^{47}Ca than age-matched controls. Possible explanations of the differences in results among different age groups and between fracture patients and healthy individuals are discussed. No significant differences in plasma elimination and urinary excretion of the isotope were found between healthy persons and fracture patients. The bone salt density was numerically but not significantly decreased in fracture patients compared with healthy controls. (auth)

32352 METABOLISM OF NUCLEIC ACIDS AND CATECHOLAMINES IN INTERNAL USE OF RADON WATER. Rakhmanova, T. B. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 33: 37-43(Jan 1968). (In Russian).

A two-week treatment with Essentuki-17 (radon water) introduced into the stomach immediately before eating reduced the weight of the thyroid gland and the concentration of ascorbic acid in the adrenal gland of white rats, which indicated an increased secretion of the corticosteroids. Experiments with water intake 1.5 hr before eating produced identical results. In both experiments the absorption of radioactive iodine by the thyroid gland tissue was inhibited and the weight of the adrenal and seminal glands remained unchanged. (R.V.J.)

32353 EFFECTS OF THE AGROCHEMICAL PROPERTIES OF SOIL ON THE UPTAKE OF ^{90}Sr BY CEREAL CROPS. Ivanov, S. N.; Shagalova, E. D.; Shifrina, S. S. (Inst. of Soil Science and Agrochemistry, Minsk). Dokl. Akad. Nauk BSSR; 14: 355-8 (Apr 1970). (In Russian).

The relation between the agrochemical properties of the soil and the uptake of ^{90}Sr by winter rye, barley, and oats was investigated. A negative correlation was established between the exchangeable acidity of the soil and ^{90}Sr accumulation in the grain and straw, and also between the degree of soil saturation by bases and the content of ^{90}Sr in the grain and the straw of the crops. Expressed either as pCi/kg of plant mass or as Sr units, the high coefficient of correlation is evidence of the validity of the relation between the indexes. (tr-auth)

32354 ASSESSMENT OF INCORPORATION RISKS. Moehrle, G.; Schieferdecker, H. (Kernforschungszentrum, Karlsruhe, Ger.). Radiologe; 10: 381-5(Sep 1970). (In German).

Radioisotope incorporation in medicine is discussed with respect to effective half-life, characteristics of emitted radiation, incorporation mechanism, and distribution in the body. In addition, measurements of incorporated amounts are discussed with respect to whole-body counters, indirect assessment through excretion analysis, frequency of incorporation measurements, and dose assessment based on results obtained by incorporation measurements. (H.B.G.)

Radiation Effects

Refer also to abstracts 31953, 31977, 32004, 32007, 32447, 32551, and 32590.

32355 (AEC-tr-7205) RADIOBIOLOGY. Translation of Radiobiologiya; 10: No. 4, 483-640(1970). 253p. Dep. NTIS.

The 34 papers appearing in this cover-to-cover translation were prepared previously for NSA and appear in Vol. 25 issue 6 as abstract numbers 10941, 10942, 10965-73, 10985, 10986, 11013-8, 11099-103, 11269-73, and 11278; and in issue 12 as abstract numbers 26907 and 27015-7. (E.R.B.)

32356 (CONF-690841-(Absts.)) ABSTRACTS. Third International Biophysics Congress of the International Union for Pure and Applied Biophysics at Cambridge, Massachusetts (USA), August 29-September 3, 1969. (Massachusetts Inst. of Tech., Cambridge). 316p.

Abstracts of some 600 papers presented at this congress are presented. Topics discussed include: the structure, function, and physical chemistry of proteins and nucleic acids; the structure and permeability of cell membranes; the structure of central nervous system and muscular tissues; photosynthesis; the effects of ionizing radiations on cultured cells, cell membranes,

and molecules in cells; mathematical models for biological processes; and the development of new techniques for biophysical studies. (C.H.)

32357 (CONF-691227) MACROMOLECULES IN STORAGE AND TRANSFER OF BIOLOGICAL INFORMATION. Proceedings of a Symposium held at Bhabha Atomic Research Centre, Bombay, December 15–17, 1969. (Department of Atomic Energy, Bombay (India). Biology and Medical Committee). 1970. 555p.

Separate abstracts were prepared for five papers presented at the conference. An additional 47 papers were presented on the structure and function of nucleic acids. (H.L.W.)

For abstracts of individual papers see: 32007, 32363, 32590, 32622, and 32623.

32358 (COO–1793-4) ISOLATION OF ULTRAVIOLET LIGHT-INDUCED PYRIMIDINE DIMERS FROM ENZYMATIC HYDROLYSATES OF DNA. Small, Gary D.; Sparks, Robert B. (South Dakota Univ., Vermillion. Dept. of Biochemistry). [9 Sep 1970]. 21p. Dep. NTIS.

A method has been developed for the isolation of ultraviolet light-induced pyrimidine dimers from enzymatic hydrolysates of DNA. The dimers are isolated in the form TpT, thus making it possible to use ^{32}P-labeled DNA for the study of ultraviolet light-induced pyrimidine dimers. (auth)

32359 ACTION OF ELECTROMAGNETIC RADIATIONS ON PROTEINS. II. IRRADIATION OF BOVINE SERUM ALBUMIN BY ULTRAVIOLET RAYS. Colson, C.; Fredericq, E. (Univ., Liege). Bull. Cl. Sci., Acad. Roy. Belg.; 56: 983-1000(1970).

Bovine serum albumin solutions (1 g/dl, pH 7) were treated by uv radiation in air and in nitrogen. The absorbance in the range 250 to 325 nm was strongly increased by irradiation. Similar effects were observed by irradiation of protein hydrolysates. They probably resulted from formation of oxidation products of the aromatic rings. At low doses irradiation brought about an unfolding of the molecule without changing the molecular weight as shown by viscosity and sedimentation measurements. At higher doses, aggregation occurred and was particularly strong after irradiation in nitrogen. Amino acid analysis revealed a strong destruction of aromatic, sulfur-containing, and basic residues, at high doses. Optical levorotation decreased at low doses and increased at higher doses due to the destruction of the asymmetric environment of carbon atoms and disruption of the helical structure; this was confirmed by optical rotatory dispersion measurements. Enzymic susceptibility towards trypsin and chymotrypsin was increased by the denaturing effect of irradiation. Irradiation with filtered light gave essentially the same results. The effects of ozone on similar properties of serum albumin were also determined and found to be different from the effects of uv radiation. Conclusions were made regarding the similarities between the effects of γ and uv. (auth)

32360 CHARACTERIZATION OF THE FACTOR IN L-CELL CONDITIONED MEDIUM CAPABLE OF STIMULATING COLONY FORMATION BY MOUSE MARROW CELLS IN CULTURE. Austin, P. E.; McCulloch, E. A. Till, J. E. (Univ. of Toronto. Ontario Cancer Inst., Toronto). J. Cell. Physiol.; 77: 121-33(Apr 1971).

Medium harvested from cultures of mouse L-cells contains conditioning factor activity (CFA) that may be detected by its ability to stimulate colony formation by mouse marrow cells in culture. The active material has been characterized and appears to be a glycoprotein with properties similar to those reported for the colony-stimulating activity in human urine. Characterization of trypsin-digested material indicated that only part of the molecule is essential for biological activity. The CFA has been partially purified from serum-free L-cell conditioned medium, and evidence has been obtained that radioactivity derived from labeled valine or glucosamine may be incorporated into the factor. L-cell conditioned medium appears to be a convenient source of partially-purified, highly active material, suitable for use in studies on its mechanism of action. (auth)

32361 GELFILTRATION STUDIES OF U. V. IRRADIATED RIBONUCLEASE A. IV. Mueller, H.-G. (Institut fuer Biophysik, Berlin). Stud. Biophys.; 20: 23-9(28 Feb 1970). (In German).

By means of oxidation and subsequent gel filtration on Sephadex G 50 of ribonuclease A irradiated with uv light, the average number of intermolecular cross links and of breaks in the polypeptide chain was determined. Enzyme samples with a residual activity of 37% showed 0.020 crosslinks and 0.082 breaks per molecule. (auth)

32362 RESPONSE OF HISTONE TURNOVER AND PHOSPHORYLATION TO X IRRADIATION. Gurley, Lawrence R.; Walters, Ronald A. (Los Alamos Scientific Lab., N. Mex.). Biochemistry; 10: 1588-93(27 Apr 1971).

Previous studies indicated that histone f1 turnover in cultured Chinese hamster cells could be stopped by x radiation. Experiments were designed to determine whether there was any temporal correlation between this period of inhibited f1 turnover and the radiosensitive phosphorylation of f1. Significant rapid histone phosphorylation was detected only in fractions f1 and f2a2 after histones had been purified by either preparative polyacrylamide gel electrophoresis or IRC-50 chromatography. The phosphorylation of f2a2 was insensitive to x radiation, while the phosphorylation of f1 was decreased by 50% 1 hr after irradiation with 800 rads. The phosphorylation of f1 returned to 86% of control by 3-hr postirradiation. The normal turnover of f1 in chromatin was completely stopped for 3 hr after irradiation and then resumed at an accelerated rate. The concomitant reduction and recovery of f1 turnover and phosphorylation after irradiation suggest that these two biochemical properties of f1 are related to the same biological function of this histone. After irradiation, DNA replication continued at the same rate as in unirradiated cultures as measured by DNA mass increase. However, [^3H]thymidine incorporation into DNA was reduced by irradiation. Therefore, histone f1 phosphorylation does not appear to correlate with DNA replication per se but, rather, with some form of radiosensitive precursor incorporation into DNA. (auth)

32363 EFFECT OF GAMMA IRRADIATION ON THE INDUCTION OF ASPARAGINE SYNTHETASE IN POTATOES. Nair, P. Madhusudanan; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). pp 281-304 of Macromolecules in Storage and Transfer of Biological Information. Bombay; Department of Atomic Energy (1970).

From Symposium on macromolecules in storage and transfer of biological information; Bombay, India (15 Dec 1969). See CONF-691227.

Asparagine synthetase activity was enhanced by gamma irradiation of potatoes at sprout inhibiting dose. This process was dose-dependent and maximum activation was obtained between 5 and 25 Krads. 10 Krad was the optimum dose. Purified asparagine synthetase gave L-asparagine, ADP and Pi as products of the reaction. Maximum activation was obtained at 24 hrs after irradiation. Formation of asparagine synthetase followed the same pattern as protein synthesising capacity assessed by ^{14}C-leucine incorporation. The buds from irradiated potatoes were the main site of this activation. They were able to incorporate 2-^{14}C-uracil into their DNA and RNA and ^{14}C leucine into their protein. Chloramphenicol, cycloheximide, puromycin and actinomycin D inhibited this incorporation as well as enzyme activity. When the enzyme was purified from the buds, after incubation with ^{14}C-leucine, there was good correlation between the incorporation of ^{14}C-leucine into the enzyme fraction and increase in specific activity. Under the optimal conditions for protein synthesis, there was complete synthesis of the enzyme in the buds, as measured by the increase in specific activity and ^{14}C-leucine incorporation into enzyme protein. I-asparagine offered a feed back control on enzyme synthesis. It is concluded that there is a transient gene activation by gamma irradiation resulting in the synthesis of asparagine synthetase. (auth)

Immunology

Refer also to abstracts 32545, 32566, and 32567.

32364 METABOLISM OF DIFFERENT IMMUNOGLOBULIN CLASSES IN IRRADIATED MICE. IV. FATE OF CIRCULATING IgA OF TUMOUR OR TRANSFUSION ORIGIN. Bazin, H.; Levi, Gabriella; Heremans, J. F. (Univ. St. Pierre, Louvain, Belgium. CNEN–EURATOM, Rome). Immunology; 20: 563-70(Apr 1971).

BALB/c conventional mice carrying plasma cell tumour grafts which secrete IgA did not, in contrast to normal mice, experience any decline in their serum IgA levels following wholebody irradiation by 900 R, provided the tumours themselves were protected from x-ray damage. Germ-free Swiss mice whose serum IgA levels had been raised to near-normal values by a transfusion with normal mouse serum, did not show any selective decline in the serum IgA concentration following whole-body-exposure to 2000 R, in contrast to conventional adult mice. Nor did germ-free transfused mice excrete abnormally high quantities of IgA into their intestinal fluids. (auth) (UK)

32365 RADIORESISTANCE OF THE ENHANCING EFFECT OF CELLS FROM CARRIER-IMMUNIZED MICE IN AN IN VITRO PRIMARY IMMUNE RESPONSE. Kettman, J.; Dutton, R. W. (Univ. of California, San Diego, La Jolla). Proc. Nat. Acad. Sci. U. S. A.; 68: 699-703(Apr 1971).

XUM

The in vitro primary response of mouse spleen cell suspensions to 2,4,6-trinitrophenyl(TNP)-erythrocytes was studied. The number of anti-TNP plaque-forming cells that arise after antigenic stimulation in vitro is greatly enhanced by prior immunization in vivo with the carrier erythrocyte. The enhancement is antigen specific. The priming for an enhanced response can be elicited with very low antigen doses and is often apparent 24 hr after immunization. It is marked from day 3 to day 14. Spleen cells from carrier-primed mice will enhance the anti-TNP response of normal cells when mixed cultures of the two cell populations are challenged with TNP-erythrocytes in vitro. The carrier-primed cells mediating this enhancing effect are thymus derived. The development of the thymus-derived, carrier-specific cell population has been generally assumed to involve the antigenic stimulation of cell proliferation. It was, therefore, somewhat surprising to find that the enhancing effect of the carrier-primed cells, once they had been generated, is not inhibited by x irradiation. (auth)

32366 MORTALITY AND GROSS PATHOLOGY OF SECONDARY DISEASE IN GERMFREE MOUSE RADIATION CHIMERAS. Jones, J. Miriam; Wilson, Raphael; Bealmear, Patricia M. (Univ. of Notre Dame, Ind.). Radiat. Res.; 45: 577-88(Mar 1971).

On the hypothesis that elimination of the microbial flora of the host might avert or delay the fatal effects of graft-versus-host (GVH) reactions and mitigate the pathology of secondary disease, a study was made of allogeneic and xenogeneic radiation chimeras utilizing rigidly inbred germfree and conventional animals. Germfree C3H/He mice irradiated with 1000 R x radiation and given 10^7 DBA/2 bone marrow cells had a 98% survival 120 days postirradiation. By contrast, conventional C3H/He mice irradiated with 825 R and given 10^7 DBA/2 bone marrow cells had a 64% survival at 30 days and a 0% survival at 120 days postirradiation. Gross evidence of secondary disease was rare in the germfree allogeneic chimeras while, by comparison, the conventional allogeneic chimeras presented the symptoms of secondary disease usually observed in other laboratories. Germfree status did not prevent secondary disease or death in the xenogeneic (Fisher 344 rat to C3H/He mouse) chimeras, but did prolong mean survival time. The results support the concept that in the mouse GVH reactions resulting from allogeneic bone marrow transplantation are not necessarily fatal if the microbial flora of the host is restricted or eliminated. (auth)

32367 IMMUNITY TO AEROSOL CHALLENGE IN GUINEA PIGS IMMUNIZED WITH GAMMA-IRRADIATED VENEZUELAN EQUINE ENCEPHALITIS VACCINES. Reitman, Morton; Tonik, Ellis J. (Medical Sciences Labs., Frederick, Md. Aerobiology and Evaluation Labs., Frederick, Md.). Appl. Microbiol.; 21: 688-92(Apr 1971).

It was previously found that nonviable Venezuelan equine encephalitis (VEE) vaccines prepared by exposure of virus suspensions produced in WI-38 cells to ionizing radiations were highly effective in protecting guinea pigs subjected to intraperitoneal (ip) challenge with VEE virus. To characterize further the efficacy of irradiated vaccines, guinea pigs were immunized with three lots of vaccine inactivated by exposure to 8×10^6 r of gamma rays and then were challenged via the respiratory route with aerosols of VEE virus. Animals that received a series of three ip inoculations of vaccine at 1-week intervals showed high levels of resistance to aerosol challenge. The 50% effective dose values of vaccines ranged from <0.0016 to 0.0051 ml for respiratory challenge and from <0.00074 to 0.0011 ml for intraperitoneal challenge. Serological studies showed that antigenicity of the irradiated vaccines was excellent. Moderate to high levels of serum-neutralizing and hemagglutination-inhibiting antibodies were demonstrated in the majority of animals vaccinated with undiluted or 10^{-1} dilutions of the vaccines. However, serum-neutralizing and hemagglutination-inhibiting antibody levels were not always indicative of the level of immunity, because some animals in which significant antibody could not be demonstrated were able to survive challenge with VEE virus. (auth)

32368 COMPARATIVE DATA CONCERNING THE ACTION OF HYDROCORTISONE AND IRRADIATION ON IMMUNOGENESIS. Nikolaev, A. I.; Safaeva, I. B.; Rozgon, M. I. (Tashkent Inst. of Medicine). Zh. Mikrobiol., Epidemiol. Immunobiol.; 47: No. 8, 64-8(1970). (In Russian).

A study was made on the effects of hydrocortisone (90 mg/kg) and irradiation (700 g) on the number of live nuclear and antibody forming cells in the spleen of intact animals, and also of animals immunized with sheep erythrocytes at various periods before and after the action of the mentioned factors. These comparative experimental investigations were carried out on albino mice. Irradiation, which affected mainly the poorly differentiated cells of lymphoid tissue and which considerably depressed the process of proliferation of nuclear and antibody forming cells, prolonged the inductive phase of antibody formation. Hydrocortisone destroyed the lymphoid cells irrespective of their differentiation, and produced practically no effect on the processes of proliferation of antibody forming cells during the first days after the immunization, but had no significant influence on the duration of inductive phase of antibody formation. However, the number of antibody forming cells and the antibody titer were considerably lower than in control animals. (auth)

32369 IMMUNOPRECIPITINS IN SCHISTOSOMA MANSONI INFECTIONS. III. CERCOPITHECUS SABAEUS AND MACACA MULATTA MONKEYS EXPOSED TO IRRADIATED CERCARIAE AND SUBSEQUENTLY CHALLENGED. Hillyer, George V. (Univ. of Chicago); Frick, Lyman P. Exp. Parasitol.; 29: No. 1, 53-8(Feb 1971).

Three Macaca mulata (rhesus) and eight Cercopithecus sabaeus (green) monkeys received four exposures, at intervals of approximately 6 weeks, to 3000 ^{60}Co-irradiated Schistosoma mansoni cercariae. Each of the rhesus monkeys was subsequently exposed twice to 1000 normal cercariae, and each of the green monkeys subsequently received two exposures of 200 normal cercariae. Double-diffusion studies using homogenates of sonicated cercariae, adult worms, and eggs as antigens showed that strong immunoprecipitins appeared only after challenge to normal cercariae and after worm maturation and oviposition. Serum protein changes observed by immunoelectrophoresis showed a rise in the immunoglobulin M fraction, usually concurrent with the immunoprecipitin response. (auth)

Ecology

Refer also to abstracts 32391, 32392, 32396–32399, 32402, 32409, and 34391.

32370 (GAT-629) ENVIRONMENTAL RADIATION LEVELS AND CONCENTRATIONS, SECOND HALF AND ANNUAL SUMMARIES, 1970. Kalmon, B.; Hulett, S. H. (Goodyear Atomic Corp., Piketon, Ohio). 20 Apr 1971. Contract AT(33-2)-1. 14p. Dep. NTIS.

The average environmental radiation levels for the Goodyear Atomic Corporation gaseous diffusion plant, for the second half of 1970 and for the calendar year 1970, are summarized in this report which is prepared in accordance with the policy of the Atomic Energy Commission. The results for the first half of 1970 were previously reported in GAT-628 but are also included in tabulated form in this annual summary. For the second half of 1970, the water alpha, water beta-gamma, air alpha, and the penetrating background dose rates increased when compared with the first half values. The air beta-gamma value decreased when compared to the first half value. In comparing values for calendar year 1970 with calendar year 1969, the water alpha and air alpha decreased in 1970 while the water beta-gamma and air beta-gamma increased. The penetrating background dose rates remained essentially unchanged. (auth)

32371 (STI/PUB-268) NUCLEAR TECHNIQUES IN ENVIRONMENTAL POLLUTION. Proceedings Series. Proceedings of a Symposium on Use of Nuclear Techniques in the Measurement and Control of Environmental Pollution, Salzburg, 26–30 October 1970. (International Atomic Energy Agency, Vienna (Austria)). Feb 1971. 824p. (In several languages). (CONF-701023). IAEA $22.00.

Separate abstracts were prepared on 40 of the 43 papers presented at this conference. (C.H.)

For abstracts of individual papers see: 31822, 31823, 31870–31886, 31963, 32079–32082, 32086–32089, 32094, 32095, 32143–32145, 32256, 32296, 32297, 32323, 32350, 32375, and 32376.

32372 (UCLA-12-818) CYCLING OF STABLE Cs IN A DESERT ECOSYSTEM. Wallace, A.; Romney, E. M.; Wood, R. A. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). [1970]. Contract AT(04-01)-Gen-12. 14p. (CONF-710501-4). Dep. NTIS.

From third national symposium on radioecology; Oak Ridge, Tenn. (10 May 1971).

32373 INFLUENCE OF HUMAN ACTIVITY UPON ^{226}Ra MIGRATION IN THE ENVIRONMENT. Wlodek, Stanislaw; Grzybowska, Danuta; Bysiek, Maria. Nukleonika; 15: 675-81(1970). (In Polish).

Radium-226 concentrations in industrial wastes, water, bottom

sediments, and periphyton of a small river and its ten tributary streams, as well as in soil and meadow plants was investigated in an area of somewhat elevated natural radioactivity. A distinct influence of the human activities upon migration and cumulation of radium in bottom sediments and river periphyton was established. As a result of the 2-year-period of industrial activity in the drainage area of the above mentioned river a long zone of increased radium concentrations (about 10 km) involving the immediate vicinity of the river as well as the flood land around was formed; this zone does not present, however, any significant health hazard to the resident population. (auth)

32374 ^{90}Sr CONTENT OF PEAT-BOG SOILS. Ivanov, S. N.: Shagalova, E. D.: Shifrina, S. S. (Inst. of Soil Studies and Agrochemistry, Minsk). Dokl. Akad. Nauk BSSR; 14: 849-52(Sep 1970). (In Russian).

The Sr-90 content and its behavior in peat-bog soils were investigated. It was found that ^{90}Sr permeates more deeply in lowland peat-bog soils than in mineral soils. Such vertical migration of the activity increases with the degree of swampiness of the turf. In higher, transitional types of bogs, ^{90}Sr largely precipitates from sediments brought in as a result of surface water runoff, and becomes fixed in the upper mossy layer of the soil. (tr-auth)

32375 LIMITATIONS AND NEEDS FOR NUCLEAR TECHNIQUES IN ENVIRONMENTAL CONTROL. Terrill, J. G. Jr. (World Health Organization, Geneva). pp 81-9 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The application of nuclear techniques in the environmental field has been under study since radioisotopes became available. They were intensified by the advent of activation analysis and the fall-out from weapons testing, which provided data for many scientific fields but particularly for meteorology and ecology. A decade ago it was assumed that the basic limitations were the recommendations of the NCRP and ICRP. This was later shifted to the viewpoint of the Federal Radiation Council that required a risk/benefit evaluation for the inauguration of large-scale uses of radioisotopes that resulted in discharge into the environment. The present thinking has not only been influenced by the students of radioactivity, but also by threats to the environment by substances that have been considered to be safe, such as DDT and mercury. Persistence plus diversification of ecological patterns has led to legislative, regulative, and judicial action to eliminate environmental discharges of materials having carcinogenic, teratogenic, and mutagenic effects, and the capability of persistence in diverse ecological systems. The need to eliminate these substances decreases the flexibility of use of radioisotopes, but it also presents opportunities for their use. A typical situation is the current concern about mercury in waterways. Mercury contamination may last 10 to 100 years. An interim standard exists for drinking-water and fish, but none exists for water generally. It is believed that paper and chemical plants are the principal sources. The pathway to fish is more devious and presumably involves methylation of the metal. The extent to which activation analysis techniques can be utilized for a systems-approach to this ecological problem is discussed. This includes a review of the physical and laboratory parameters; field applications, and the integration of the data into a meaningful evaluation of the risk. In addition to the normal system of sampling and analysis in the laboratory, new techniques employing ultra-low-level and rapid neutron analysis have been developed for metals with neutron cross-sections in the same range as mercury. The degree to which this method can be used for mercury contamination is analyzed and discussed. (auth)

32376 SPECIFIC ACTIVITY CONCEPT APPLIED TO AQUATIC ECOSYSTEMS. Nelson, J. J.; Kaye, S. V. (Oak Ridge National Lab., Tenn.). pp 735-46 of Nuclear Techniques in Environmental Pollution. Vienna; International Atomic Energy Agency (1971).

From Symposium on the use of nuclear techniques in the measurement and control of environmental pollution; Salzburg, Austria (26 Oct 1970). See STI/PUB-268; CONF-701023.

The specific activity concept is useful for predicting the quantitative behavior of radionuclides in the environment. In contrast, data from radiotracer releases are principally useful for interpreting environmental pathways of inorganic elements. Specific activity studies were used to quantify the complete material balance in aquatic organisms. Predictions of the concentration of ^{90}Sr and ^{137}Cs in fish were made by measuring the stable element concentrations in fish and water. For steady-state releases of radionuclides the simple specific activity (pCi/g total element) is an accurate predictor. Temporal variations in ambient radionuclide concentrations may affect the accuracy of the predictions but these variations are a function of the biological half-time of the element in fish. For radionuclides with long effective half-times fish act as integrating samplers of environmental radioactivity. Radionuclide concentrations (pCi/g of organism) may require the use of specific activities for interpretation of biophysical phenomena. Analyses show that the stable Cs content of fish flesh varies with fish size, as does the stable Sr content of clam shells. For instance, a clam shell containing 220 ppM Sr and 100 pCi ^{90}Sr/g of shell is ecologically equivalent to a shell containing 550 ppM Sr and 250 pCi ^{90}Sr/g of shell. Numerous examples are cited that illustrate and explain the proper interpretation of data with respect to environmental radioactivity. Studies have shown that for any meaningful interpretation of concentrations, pCi/g of organism, it is advisable to analyze for stable elements of the radionuclides being determined. Application of specific activities has been particularly useful for research in aquatic environments where this concept appears to have most validity, as opposed to terrestrial systems, for predicting and interpreting radionuclide behavior in ecosystems. (auth)

32377 EXISTENCE AND THE ROLE OF CESIUM IN THE NATURAL ENVIRONMENT, PARTICULARLY AQUATIC ENVIRONMENTS. II. RESULTS OF RESEARCH ON THE CONTAMINATION OF FRESHWATER ECOSYSTEMS BY RADIOCESIUM. Wlodek, Stanislaw (Centralne Laboratorium Ochrony Radiologicznej, Warsaw). Ekol. Pol., Ser. B; 14: 199-220(1968). (In Polish).

Examinations were made of the ^{137}Cs content of water, sediments, and 17 species of aquatic plants in several fresh-water reservoirs in Poland and France during the four years that followed nuclear testing (1963 to 1966). During this period the ^{137}Cs content was on the order of a few parts per billion. It was observed that there was a tendency for the fallout ^{137}Cs in the aquatic medium to be deposited on the immersed aquatic plants and sediments. Self purification of ^{137}Cs in water was a rapid and effective process in reservoirs of small depth and stagnant water. Observations on sediments showed that ^{137}Cs was retained longer by sediments of high organic content. Experimental studies were also conducted using 54 vinyl basins containing cultures of the following plants: Phragmites communis, Nasturtium officinale, Lemna minor, Ulothrix sp., and Elodea canadensis. Cesium-137 was added to the basins in the following concentrations: 4; 0.43; and 0.046 μCi/l. Results indicated that aquatic plants play a considerable role in accumulation, distribution, and migration of ^{137}Cs. An equation was developed for calculating the coefficient of accumulation of ^{137}Cs by aquatic organisms. (H.L.W.)

Genetics and Cytogenetics

Refer also to abstracts 32458, 32459, 32541, 32622, 32624, and 32631.

32378 ANALYSIS OF A CASE OF MUTAGEN SPECIFICITY IN NEUROSPORA CRASSA. III. FRACTIONATED TREATMENT WITH DIEPOXYBUTANE (DEB). Auerbach, C.; Ramsay, D. (Inst. of Animal Genetics, Edinburgh). Mol. Gen. Genet.; 109: 285-91(31 Dec 1970).

Weak doses of DEB given before or after a moderately high dose act as "booster" for the production of adenine-reversions. Fractionation of a moderate or high dose into a succession of weak ones yields a dose-effect curve that lies above the linear curve expected for additivity of the fractions but below that found after continuous exposure. The results lend support to the view that DEB, in addition to producing potential adenine-reversions in DNA, promotes their realization by its effect on some cellular process or processes, and that this is the cause of the steep dose-response to continuous exposure. (auth) (UK)

32379 POSSIBLE INFLUENCE OF A SINGLE GENE LOCUS ON LIFE SPAN AND ITS RELATIONSHIP TO RADIATION RESISTANCE AND ACTIVITY. Spalding, J. F.: Brooks, Mary R. (Los Alamos Scientific Lab., N. Mex.). Proc. Soc. Exp. Biol. Med.: 136: 1091-3(Apr 1971).

Two lines of RFM mice were serotyped and both H-2^k and H-2^f serotypes were segregating in each line. Two sublines were developed within each of the two lines so that each line had an H-2^k and an H-2^f subline. Radiation resistance characteristics were shown to segregate with the H-2 serotype, with H-2^k mice showing more resistance to protracted gamma-ray exposure than the H-2^f mice. The tabulated results show that the life span was 51 days longer in the H-2^f line. Since the two sublines are known to differ only at the H-2 gene locus, it was concluded that a single gene locus may have a significant effect on longevity. (H.L.W.)

XUM

32380 CHROMOSOME DAMAGE IN THYROID CELLS OF ADULTS IRRADIATED WITH X-RAYS IN INFANCY. Doida, Y.; Hoke, C.; Hempelmann, L. H. (Univ. of Rochester, N. Y.). Radiat. Res.; 45: 645-56(Mar 1971).

Chromosomes were examined in the metaphase figures obtained from cultured neoplastic and nonneoplastic cells of the thyroid glands of the following three groups of patients with nodular thyroid disease: four patients treated with x rays in infancy and given ^{131}I preoperatively; seven patients not treated with x rays but given ^{131}I; and three patients not exposed to either x rays or ^{131}I. Aneuploid metaphases were more frequent in the cultured cells of the x-irradiated group than in the control groups with the percent aneuploidy being higher in nonneoplastic cells. The frequency of unstable aberrations, although low in both neoplastic and nonneoplastic cells, approximately 3.5% in each, was ten times higher than that in all cells of both control groups. The frequency of stable aberrations was high in both cell types of the x-irradiated group (mean of 32.6% in nonneoplastic cells and 22.6% in neoplastic cells) and low in the controls (2% or less in both cell types). In two of three x-irradiated patients, the frequency of stable aberrations in nonneoplastic cells was almost twice that in the neoplastic cells. The results confirmed an observation reported previously of frequent chromosome aberrations in the adenomatous thyroid cells cultured from a patient treated with x rays many years before. The presence of chromosome aberrations in up to one of every three cells as long as 37 years after exposure to x ray indicated that lasting radioinduced cellular damage has occurred. This is consistent with the multistage theory of carcinogenesis, which is thought to apply to the induction of thyroid neoplasms by radiation exposure in man. (auth)

32381 RECOVERY PHENOMENA IN YEAST SACCHAROMYCES CEREVISIAE. III. THE EFFECT OF UV- AND X-RAY SENSITIVITY MUTATIONS ON LIQUID HOLDING RECOVERY OF GENETIC LESIONS. Arman, I. P.; Kuznetsova, O. B.; Dutova, T. A. (Inst. of Atomic Energy, Moscow). Genetika; 7: No. 3, 107-19(Mar 1971). (In Russian).

The effects of uv and x-ray sensitive mutations on liquid holding recovery (LHR) of genetic damage resulting in cell death or intergenic mitotic recombination were studied in diploid yeast Saccharomyces cerevisae. Three strains homozygous for uvs_1, uvs_3, and uvs_4 mutations, respectively did not exhibit LHR of lethal lesions after uv irradiation, nor did the strains homozygous for xrs_1, xrs_2, and xrs_4 after gamma irradiation. The x-ray sensitive mutations (xrs_1 and xrs_4), though increasing uv sensitivity, had no effect on LHR of viability. Since these two mutants recover uv but not gamma ray induced lesions, it was concluded that the ways of LHR of lethal lesions induced by various agents are different. Mutants incapable of recovering lethals are often capable of recovering lesions resulting in mitotic recombination. It means that the mode of LHR is specific to the type of genetic damage rather than to the agents causing that damage. The data obtained give some evidence that the LHR systems are significantly different in yeast and in bacteria. (auth)

32382 ARTIFICIAL SEX REGULATION IN SILKWORM (BOMBYX MORI L.). II. SEX-LABELLED HYBRIDS OF THE SILKWORM WITH MALES OF NORMAL VIABILITY. Strunnikov, V. A.; Gulamova, L. M. (Middle Asian Research Inst., Tashkent. Inst. of Developmental Biology, Moscow. Univ. of Tashkent). Genetika; 7: No. 3, 58-73(Mar 1971). (In Russian).

In the sex-linked breeds and hybrids of Bombyx mori, the males with the genotype w_2/w_2 (white eggs and eyes) have a somewhat reduced viability that is a drawback for their industrial breeding. For the purpose of the elimination of this defect certain new egg color mutations were induced by gamma irradiation that proved to be more suitable for the creation of sex-marked breeds. The phenotypic effect of the mutation w_2^{br} induced in the $locus^{+w_2}$ was the lack of pigment in the egg serosa (in a homozygous state) and the brown eye color in adult butterflies; the viability of eggs and larvae in the new mutant line was higher than in the mutant w_2 but nevertheless it was below normal. (P.B.M.)

32383 X-RAY INDUCED LIFE-SHORTENING MUTATIONS IN HABROBRACON: A GENETIC APPROACH TO SENESCENCE AND DURATION OF LIFE. Baird, M. B.; Clark, A. M. (Masonic Medical Research Lab., Utica, N. Y. Univ. of Delaware, Newark). Exp. Gerontol.; 6: No. 1, 1-8(Feb 1971).

Habrobracon males were exposed to x radiation. Two mutations that decreased the adult life span of mutant wasps were isolated after screening the first-generation daughters of the irradiated mates. Both lethals produced a substantial decrease in longevity of mutant males. However, the mutations differed from each other as regards the time of onset of mortality, the range in days over which death occurred, and the appearance, or gross pathology, of the dead wasps. The existence of adult lethal mutations is interpreted to offer support for a developmental model for the control of duration of life. Termination of adult life as a consequence of a single gene mutation appears to mimic termination of preadult development through an analogous process. It was concluded that introduction of a genetic variable in the form of life-shortening mutations would prove useful in elucidating the role of genes in the control of adult life span. (auth)

32384 IONIZING RADIATION AND CHEMICAL MUTAGENS AS FACTORS INCREASING GENETIC VARIETY IN GLADIOLUSES. Dryagina, I. V. (Moscow State Univ.). Izv. Akad. Nauk SSSR, Ser. Biol.; 35: No. 6, 879-83(1970). (In Russian).

Experimental data on the treatment of gladiolus bulbs, seed, and pollen with chemical mutagens (nitrosomethylurea and nitrosoethylurea) and ^{60}Co γ irradiation are presented. Data are given for germination of irradiated pollen on an artificial nutritive medium, the fertilizing ability of such pollen in crosses as well as information concerning the germination power, growth, and development of experimental plants. Gladioli proved to be a culture resistant both to radiation and chemical mutagens. Pollen exposed even to such strong doses as 100 to 120 kR contained 17 to 23% of germinated pollen grains. Gladioli bulbs treated with NMU and NEU at concentrations of 0.2 to 0.3% retained a sufficiently high germination ability (44 to 46%). Irradiation of pollen and seeds of gladioli and treatment with chemical mutagens increased the genetic variability of their seedings. (auth)

32385 ACHIEVEMENTS OF THE MUTATION BREEDING IN THE USSR. Shkvarnikov, P. K. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 4: 108-22(Mar-Apr 1970). (In Russian).

A brief review is given of investigations using experimental mutations in plant breeding carried out in the USSR from 1925. Theoretical and practical results concerning the mutagenic efficiency of physical, chemical, and physiological factors, comparative study of frequency, spectra, and practical value of induced mutations; effect of physiological state of organisms on radioinduced mutation variability; nature of mutations induced in different species of plants and evolutionary and practical importance of different types of mutations are dealt with. Particular attention is paid to the newest investigations on mutation breeding in the USSR carried out with many species of agricultural plants, and to the concrete practical results of these investigations. A list is presented of some practical valuable mutant forms obtained in some species of plants, which are of interest for including them into breeding. A list and characteristics of new varieties of plants obtained by means of mutation breeding are given. (auth)

32386 GENETIC CONTROL OF RADIORESISTANCE AND SOME GENERAL PROBLEMS OF GENETICS. Zakharov, I. A. (Inst. of Physics and Tech., Leningrad). Tsitol. Genet.; 4: 123-39(Mar-Apr 1970). (In Russian).

Discussions are given on the genetic control of radio resistance in bacteria and eucaryotes, the molecular bases of repair after irradiation, and the role of the repair system in realization of induced mutations, in genetic recombination and in maintenance of stability of genetic material and spontaneous mutability. Data on radiosensitivity of mutations in yeast Saccharomyces cerevisiae are summarized. (auth)

32387 CYTOLOGICAL ANALYSIS OF THE COMBINED EFFECT OF X RADIATION AND SOME INDENE COMPOUNDS. Kaminskaya, E. A.; Mosse, I. B.; Freimanis, Ya. F. (Inst. of Genetics and Cytology, Minsk. Inst. of Organic Synthesis, Riga). Tsitol. Genet.; 4: 168-71(Mar-Apr 1970). (In Russian).

The effects of three indene compounds F-25, F-37, and F-38 on the frequency of chromosome aberrations induced by irradiation in Drosophila melanogaster were studied. The protective effects of preparations F-25 and F-38 were found, confirming the previously established protective effect of these compounds for recessive sex-linked lethal mutations. Preparation F-37 showed no effect. The process of interception and dispersion of energy from the irradiated molecule of DNA by the molecules of indenes is supposed to be the basis of the protective mechanism of the indene compounds. Some differences were observed in the mechanism of protection of chromosome aberrations in comparison with that of the recessive lethal mutations. (auth)

Health Physics and Safety

Refer also to abstracts 32191 and 33928.

32388 RADIATION SAFETY. Wilcox, Floyd W. (Sutter Community Hospitals, Sacramento, Calif.). Occup. Health Nurs.; 18: 14-17(Oct 1970).

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Radiation as an energy source shows tremendous potential as an effective tool in diagnosis and therapeutic medicine. Accurate information concerning radiation and its true potential will allow the industrial nurse to properly evaluate its significance in routine and emergency conditions. Radiation as a potential force should be properly categorized with other industrial hazards while carefully weighing benefits versus true risk. It is not likely that radiation will be a real danger to the industrial nurse even in accident situations. A few simple enumerated operational radiation safety procedures can reduce the significance of accidents involving radiation sources. The biological responses in man to various doses of radiation are given and the genetic effects are discussed. (F.M.M.)

32389 INVISIBLE HAZARD. Edmonds, C. Safety (London); No. 47, 12-15(Nov 1969).

A discussion is presented on the principles of radioisotope sources and x-ray generators, their use in measuring, monitoring and control systems in steelworks, the hazards associated with them, statutory requirements, and precautions relating to their use. (Occup. Safety and Health Abstr.)

32390 VOPROSY DOZIMETRII I ZASHCHITY OT IZLUCHENII. VYPUSK 10. (Problems in Dosimetry and Radiation Protection. Issue 10). Kimel, L. R. (ed.). Moscow; Atomizdat (1969). 172p.

Annual collections of research by the Moscow recipients of the Order of the Red Banner at the Engineering Physical Institute, original research in radiation dosimetry, protection, and spectrometry are included. This issue contains the results of research conducted through 1968. The discussions include research on dosimetry and protection against γ and corpuscular radiations, radioactive fallout, safety during spaceflights, and methods and equipment for studying radiations. The results of these investigations will undoubtedly be of value in the practical considerations of radiation protection and dosimetry. The collection of papers is intended for use by advanced students and specialists in the fields of nuclear physics and radiation dosimetry and protection. (tr-auth)

Radioactive Contamination and Decontamination

Refer also to abstracts 32333, 32334, 32339, 32341, 32342, and 32449.

32391 (AEC-tr-7216) DETERMINATION OF THE MEAN POPULATION BURDEN FROM NATURAL EXTERNAL RADIATION IN THE SOVIET ZONE OF GERMANY. Ohlsen, H. (Staatliche Zetrale fuer Strahlenschutz, Berlin (East Germany)). Translation of report SZS-14/69. 55p. Dep. NTIS.

An abstract of this article was prepared from the original language and appeared in Nuclear Science Abstracts Vol. 24: 21102. (C.H.)

32392 (CEA-R-4157) STUDY OF THE PARAMETERS OF RADIOCOBALT TRANSFER IN CONTINENTAL AQUATIC AND IRRIGATED ECOSYSTEMS. Bittel, Robert; Merlini, Margaret; Myttenaere, Constant; Ravera, Oscar (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Mar 1971. 36p. (In French). (EUR-4628). Dep. NTIS (U. S. Sales Only).

Studies on the behavior of cobalt in aquatic and irrigated systems are of great interest because of the role of cobalt as an essential element for some animals and plants, its presence in various industrial wastes, and the presence of some of its isotopes with a long half-life in nuclear wastes. Cobalt chemistry is highly complex and its behavior can be modified as a function of its physico-chemical state in wastes and in its dispersal in the environment. As a result, it is difficult to foresee and assess the hazards from a release of cobalt into chemically different environments. The studies reported had a practical purpose, that of assessing the effects of water contaminated by ^{58}Co and ^{60}Co, on the food chain of gold fish. From the results obtained on the study of ^{58}Co and ^{60}Co in a freshwater environment, the radionuclides of cobalt do not appear to be critical radioisotopes except in the case of their presence in water used for the irrigation of food crops. (auth)

32393 (EUR-4569) CONFERENCE ON THE EXTERNAL AND INTERNAL DECONTAMINATION OF WORKERS EXPOSED TO IONIZING RADIATION, MUNICH, GERMANY, 5 NOVEMBER 1969. (European Atomic Energy Community, Luxembourg. Center for Information and Documentation). Dec 1970. 66p. (In French). (CONF-691132). EUR FB 100,-.

Programs for handling personnel following external or internal contamination by radioactive materials are presented. The importance of immediate and thorough washing of all contaminated skin areas with water and the effectiveness of various decontaminating agents for the removal of radioactive materials are discussed. The person should be moved to a medical center immediately, where all clothing should be removed, thorough washing with decontaminating agents should be repeated, external monitoring for any residual radioactivity should be carried out, and an evaluation of the possibility of internal contamination should be made. It is pointed out that internal contamination may result from the intake of radioactive materials through inhalation or wounds, and rarely through ingestion. It is often difficult to determine the level of internal contamination, but the consequences of delay warrant immediate treatment if there is a possibility of internal contamination. The treatment depends on the contaminant. Methods used to hasten the excretion of radioisotopes of Po, Pu, U, alkaline metals, iodine, and of tritium and of materials labeled with ^{14}C or tritium are outlined. The effectiveness of various chelating agents (DTPA, EDTA, and TTHA) in the removal of metallic elements is evaluated. (C.H.)

32394 (FOA-4-4458) FURTHER EXPERIMENTAL STUDIES ON THE TRANSFER OF RADIOIODINE FROM PASTURE TO MILK. Auraldsson, H.; Ekman, L.; Eriksson, Aa.; Greitz, U. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Mar 1971. 15p. Dep. NTIS (U. S. Sales Only).

The relationship between a given deposition of ^{131}I on pasture and its concentration in milk from cows grazing on the contaminated pasture has been studied under typical Swedish farming conditions in three field experiments performed in 1968 and 1969. $Na^{131}I$ in water solution was sprayed onto permanent pasture and the cows were brought there for a three day grazing period and then onto uncontaminated pasture. The total secretion of ^{131}I in milk was followed for 30 days in the experiments in 1968 and for 15 days in 1969. The ratio of the calculated deposition of ^{131}I per unit area, $\mu Ci/m^2$, to the peak concentration in milk, $\mu Ci/l$, was found to be about 50. The relations between intake and milk content of ^{131}I were established by separate single oral dose administration experiments. From these relations the total activity consumed by the cows grazing on different contaminated pastures could be assessed. It was found that the fraction of ^{131}I which was retained on the edible herbage consumed by the cows was on the average 6 percent. The corresponding retention factor found for simultaneously performed experiments with ^{85}Sr was 40 percent. Assuming that no volatilization occurs for ^{85}Sr it can be concluded that as much as about 80 percent of deposited ^{131}I has disappeared, probably through volatilization in connection with the spraying procedure. (auth) (Sweden)

32395 (HASL-242) FALLOUT PROGRAM QUARTERLY SUMMARY REPORT, DECEMBER 1, 1970-MARCH 1, 1971. Hardy, Edward P. Jr. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1971. 320p. Dep. NTIS.

Separate abstracts were prepared for 8 of the 9 sections. The remaining section covered trace metal content in fallout in New York City. (M.C.G.)

For abstracts of individual sections see: 31831, 32070, 32083, 32092, and 32396-32399.

32396 (HASL-242, pp I.24-34) COMPARISON OF THE ^{90}Sr CONTENT IN BONE OF POPULATION GROUPS WITH HIGH AND LOW CALCIUM DIETS. van As, D.; Fourie, H. O. (Atomic Energy Board, Pretoria (South Africa)).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

An investigation of the effect of different dietary habits on the uptake of ^{90}Sr in bone among the White, Bantu, Indian, and Colored peoples of South Africa has been conducted. The important dietary items; milk, maize, and bread, and rib bone samples from each of the population groups have been analyzed for ^{90}Sr content since 1966. The main dietary differences include high milk consumption and Ca intake for the White population compared to the other groups and the important contribution of maize meal to ^{90}Sr intake of the Bantu population. If one assumes a discrimination factor of four against Sr in the transfer of Ca and Sr from diet to bone, independent of the mode of ^{90}Sr intake, one can show from the measured bone values that the ^{90}Sr intakes of the different population groups are all fairly similar. The ^{90}Sr contents in bone of various age groups of the different populations are presented. (auth)

32397 (HASL-242, pp I.108-20) ^{90}Sr IN THE DIET: RESULTS THROUGH 1970. Bennett, B. G. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

Estimates of ^{90}Sr intake via the total diet in New York City and San Francisco have been made since 1960 from quarterly food samplings and average consumption statistics. The dietary in-

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takes of ^{90}Sr have decreased from maximum levels during 1963 and 1964, but the declines have become more gradual in recent years due to continued nuclear testing by the French and Chinese. The annual intake in 1970 averaged 12.1 pCi/day in New York, down slightly from the previous year, and 4.2 pCi/day in San Francisco, unchanged from 1969. Dairy products account for the greatest contribution to the total ^{90}Sr intake. Grain products are second in importance during periods of heavy deposition, but vegetables become greater contributors at later times. Fruit and meat, fish, and eggs are minor contributors. Average intake levels for 1971 are anticipated to decline to at least 11.8 pCi/day in New York and 4.1 pCi/day in San Francisco, based on current nuclear testing activity. (auth)

32398 (HASL-242, pp II.1-97) HASL FALLOUT PROGRAM DATA. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

Data are presented on the content of ^{90}Sr in representative diets in New York City and San Francisco during 1970; the content of ^{90}Sr in samples of human bone from various world-wide locations collected during 1969; and the total γ activity and content of selected radioisotopes in samples of the atmosphere and lower stratosphere collected during the last half of 1970. (C.H.)

32399 (HASL-242, pp III.1-85) DATA FROM SOURCES OTHER THAN HASL. (New York Operations Office (AEC), N. Y. Health and Safety Lab.).

In Fallout program quarterly summary report, December 1, 1970-March 1, 1971.

Fallout from French nuclear tests was monitored in New Zealand and adjacent islands in the Pacific Ocean. Data collected during 1969 and 1970 are presented. Data are included on the content of ^{14}C in the atmosphere over North, Central, and South America from 1965 through 1969 and the content of ^{137}Cs in representative foods in Chicago during January, 1971. (C.H.)

32400 (HASL-242(App.)) APPENDIX TO FALI OUT PROGRAM QUARTERLY SUMMARY REPORT, DECEMBER 1, 1970-MARCH 1, 1971. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Apr 1971. 405p. Dep. NTIS.

Data are presented on the content of ^{89}Sr and ^{90}Sr in samples of atmosphere and precipitation collected at world-wide sites and in samples of drinking water and milk collected in the USA from 1954 through 1970; the content of ^{137}Cs in drinking water in the USA from 1964 through 1970; and the gamma spectrometric determination of a number of radioisotopes in samples of atmospheric fallout collected at various locations in North, South, and Central America from 1963 through 1970. Data are included on the content of stable lead in surface air samples from 1966 through 1970. (C.H.)

32401 (PEL-205) ENVIRONMENTAL RADIOACTIVITY AT THE NATIONAL NUCLEAR RESEARCH CENTRE, PELINDABA. Report for the year 1969. van As, D.; Fourie, H. O.; Vleggaar, Constance M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct 1970. 33p. Dep. NTIS (U. S. Sales Only).

Measurements made during 1969 of gross radioactivities and certain individual nuclides in samples of soil, vegetation, water, sediment, water plants, fish, milk, and agricultural products from the environment around the National Nuclear Research Center (NNRC) at Pelindaba, are reported. Gross activities are compared with values of previous years. The results of fallout measurements are included. No increases in environmental radioactivity due to the operations at the NNRC could be detected. (auth)

32402 (ORO-4066-1) INVESTIGATION OF THE UNUSUAL BEHAVIOR OF ^{137}Cs AND OTHER RADIONUCLIDES IN THE FLORIDA ENVIRONMENT. Progress Report, June 1970-April 1971. Gamble, J. F. (Florida Univ., Gainesville. Dept. of Environmental Engineering). Contract AT(40-1)-4066. 5p. Dep. NTIS.

Fallout monitoring data collected at various locations in Florida by the National Air Sampling Network, Radiation Surveillance Network, and Radiation Alert Network from 1963 through 1969 are compared with data from other areas of the USA, with emphasis on areas north and west of Florida. A steady decrease in yearly fallout and by latitude was evident. Data on the ^{137}Cs content in air filters located in Orlando, Pensacola, St. Petersburg, and Tallahassee during 1965, 1966, and 1967 and on fallout in precipitation are reviewed. The data show that Florida has not received more fallout than other areas in comparative latitudes. A comprehensive program to delineate the cause of the continued presence of elevated levels of ^{137}Cs in the Florida biosphere, milk, and vegetables is presented. Results from June 1970 to April 1971 show highest levels of ^{137}Cs in sandpine-oak scrub on dry infertile soils. These levels are much higher than in adjacent fields cultivated for annual crops. (C.H.)

32403 RADIONUCLIDES IN THE SEA. Int. At. Energy Agency Bull.; 13: No. 1, 26-31(1971).

The prevention and control of pollution of the seas by radioactive wastes are discussed. It is stressed that so far there is no scientific indication that the nuclear wastes deposited into the sea have caused harm to man, but it is recommended that a full record should be kept. The distribution of ^{54}Mn, ^{60}Co, ^{58}Co, and ^{57}Co in marine organisms is reported. (F.M.M.)

32404 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 12: 46-65(Jan 1971).

Data are summarized from fallout monitoring studies for North, Central, and South America during 1967 through 1970. Results are included from measurements of gross β activity in surface air and precipitation during September 1970; the content of ^{90}Sr in samples of air and precipitation collected during 1968 and 1969; and the content of ^{55}Fe, ^{90}Sr, ^{109}Cd, ^{95}Zr, ^{141}Ce, ^{144}Ce, ^{238}Pu, and ^{239}Pu in samples of surface air collected during 1967. (C.H.)

32405 NATURE OF URANIUM OCCURRENCE IN THE LEAVES OF COPROSMA AUSTRALIS (A. RICH.) ROBINSON. Whitehead, N. E. (Massey Univ., Palmerston North, N. Z.); Brooks, R. R.; Peterson, P. J. Aust. J. Biol. Sci.; 24: 67-73 (1971).

The distribution and chemical form of uranium was investigated in leaves collected from plants of C. australis (Rubiaceae) growing in a mineralized soil in the Buller Gorge, N.Z. Only small amounts of uranium (<10%) were found in a low molecular weight form. The predominant occurrence of uranium (65%) was as a uranium-RNA complex, which was isolated by high-voltage electrophoresis from an aqueous extract of the freeze-dried leaves. Uranium (25%) was released from the solvent extracted leaf residue by pepsin, thus revealing the presence of a uranium-protein complex. However, in view of the known dissociation constants for these two complexes, and other tests, it is clear that the majority of the uranium in vivo is in the form of a uranium-protein complex. This finding is confirmed by a differential centrifugation experiment, in which it was shown that at least 50% of the total uranium was bound to cell wall proteins. (auth) (Australia)

32406 DATA. SECTION IV. OTHER DATA. Radiol. Health Data Rep.; 12: 67-80(Jan 1971).

The content of ^{90}Sr in human bone was determined by age and geographical location in samples collected in the USA during the first three months of 1970. Data are summarized on levels of environmental radioactivity in the environs of Argonne National Laboratory (Lamont, Ill.) during July through December 1969 and of the National Reactor Testing Station, Idaho Falls, Idaho, during January through June 1969. (C.H.)

32407 DATA, SECTION I. MILK AND FOOD. Radiol. Health Data Rep.; 12: 29-44(Jan 1971).

Data are presented on the content of ^{140}Ba, ^{137}Cs, ^{131}I, ^{89}Sr, and ^{90}Sr in samples of milk collected at various locations in North, Central, and South America during September 1970. Data for the preceding 12-month period are included for purposes of comparison. (C.H.)

32408 DATA. SECTION II. WATER. Radiol. Health Data Rep.; 12: 45(Jan 1971).

Programs for the radiation monitoring of public water supplies, ground water, and surface waters in the USA are reviewed briefly. References are presented to results obtained from the sampling programs during the period 1968 through 1970. (C.H.)

32409 ENVIRONMENTAL SURVEY OF URANIUM MILL TAILINGS PILE, MEXICAN HAT, UTAH. Snelling, Robert N. (Southwestern Radiological Health Lab., Las Vegas, Nev.). Radiol. Health Data Rep.; 12: 17-28(Jan 1971).

At the request of the Navajo Tribal Council through the PHS Division of Indian Health at Window Rock, Ariz., an environmental radiological survey was conducted on the A-Z Minerals Corporation uranium tailings pile, Mexican Hat, Utah, in May 1968. The purpose of the survey was to identify any radiation hazards which might exist and recommend methods for their control. The survey included evaluation of external gamma radiation and airborne and waterborne radioactivity. The results of the survey indicate that the external radiation levels on the tailings area exceed recommended exposure limits for individuals in the general population. Therefore, the area should not be released for public use in its

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present state. Action which would permit the release of the area would involve covering the tailings with uncontaminated soil to an extent that would diminish the external radiation to an acceptable level and to stabilize the covering against wind erosion. Radiation levels in air and water do not exceed recommended exposure limits. However, to minimize the possibility of increased activity from weather conditions different from those existing during the survey, it is recommended that the tailings be stabilized against wind erosion or periodic monitoring will be necessary. (auth)

32410 SUSCEPTIBILITY OF RADIOCERIUM TO REMOVAL FROM THE BODY BY DIETHYLENETRIAMINEPENTACETIC ACID: RATIO BETWEEN DEDUCED VALUES AND CONTENT IN THE BODY. Tregubenko, I. P.; Semenov, D. I.; Sukhacheva, E. I.; (and others). Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 81-6(1970). (In Russian).

The relation between the efficiency of the chelating agent DTPA following late application, and the ^{144}Ce content of tissues was studied in rats. It was found that the quantity of Ce-DTPA complex determined in daily samples of urine constituted 10% of the content of the emitter in all soft tissues (skeletal cerium was not involved in this process). This urine-to-soft tissue ratio was valid in rats for all periods following a single application of the agent (from the 8th to the 12th day of the experiment) at a dose of 100 μ moles. Repeated injections of the complex did not change the ratio observed following the first injection. (tr-auth)

32411 AVAILABILITY OF ^{91}Y DEPOSITS IN ANIMAL TISSUES TO DTPA. Tregubenko, I. P.; Semenov, D. I.; Sukhacheva, E. I.; Men'shikova, G. A.; Belova, M. N. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 87-94(1970). (In Russian).

Variations in the time efficiency of DTPA and EDTA for the excretion of ^{91}Y in the urine of rats was studied. It was shown that a single injection of 200 μmoles of DTPA 31, 71, or 128 days after incorporation of the emitter increased sharply its excretion in urine. The efficiency of DTPA in young rats was also noted. The efficiency of EDTA was expressed to a lesser extent. It was established that in the later days of the experiment (31 to 128 days), the efficiency of both agents decreases exponentially. (tr-auth)

32412 DETERMINATION OF THE MAXIMUM POSSIBLE QUANTITY OF ^{91}Y REMOVABLE FROM THE ORGANISM BY EDTA AND DTPA. Tregubenko, I. P.; Semenov, D. I.; Men'shikova, G. A.; Belova, M. N. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 95-103(1970). (In Russian).

The possibility of determining the degree of accessibility of ^{91}Y in the tissues of animals to EDTA and DTPA was studied. Through calculations based on experimental evidence, it was determined that the fraction of ^{91}Y accessible to DTPA constituted 31 to 37.5% of the total amount incorporated by rats. Approximately the same quantity of Y was withdrawn from the tissues of animals given daily injections of the chelating agents during a two-month period, this in addition to the normal amount excreted for this period (which was about 33% of the total amount incorporated). The theoretical and practical significance of this index of chelating agent efficiency was examined. (tr-auth)

32413 CONTAMINATION OF AIR RESULTING FROM THE RESUSPENSION OF SURFACE CONTAMINATION. Cortissone, C. (CNEN, Saluggia, Italy); Ilari, O.; Lembo, G.; Moccaldi, A. G. Fis. Sanit. Prot. Radiaz.; 12: 63-79(Apr-Jun 1968). (In Italian). (RT/PROT-(69)15).

Experience of many years has shown that the main danger caused by surface contamination with radioactive matter is caused by their resuspension into the air and subsequent inhalation by humans. To calculate the maximum admissible activity in air it is necessary to establish the degree of resuspensibility of removable surface activity. For this purpose the resuspension factor K, which expresses the correlation between activity concentration in air in m^3 or cm^3 and the corresponding surface activity in m^2 or cm^2, must be determined. K depends not only on the nature of the radioactive substance, its activity, and environmental conditions but also on the measurement methods and the sensitivity of the instruments. The basic problems of resuspensibility applicable to the expression of K were examined in a comprehensive manner. The analysis took into consideration the chemical composition, the physical conditions, and the radioactivity characteristics of the contaminating substance; the consistency of the contaminating substance and its concentration; the characteristics of the covered surface, and the removability of the material, the air movement above the surface, and the prevailing atmospheric conditions such as temperature, humidity, and pressure. To obtain data on the effect of the above factors on the resuspensibility of radioactive contaminants experiments were conducted on a laboratory scale for each individual factor using both coarse suspensions of UO_2 on measured surface areas and the same material in finely powdered form. The alpha activity was determined with a scintillation counter and the beta activity was measured with a Geiger–Müller counter. Auto-absorption of alpha radiation was also taken into consideration. Air radioactivity was measured at various degrees of turbulence in samples obtained by means of an aspirator covered with a 589 mesh filter. Experiments were carried out at no air movement, at moderate air movement, and at intense air movement for periods of one to four hours. The removal of radioactive dust from the surface was determined by a smear test. By combining the results of the tests for various parameters it was possible to establish a direct connection between the contamination of a certain surface area under various conditions and the radioactivity of the air space above and thus obtain a value of 150 cm for the resuspension factor K. (TSS)

Dosimetry and Monitoring

Refer also to abstracts 32080, 32226, 32274, 32370, 32500, and 34406.

32414 (KFKI-71-12) TWO CODES FOR CALCULATION OF DOSE DISTRIBUTION IN HUMAN PHANTOMS IRRADIATED BY EXTERNAL PHOTON SOURCES. Koblinger, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [nd]. 15p. Dep. NTIS (U. S. Sales Only).

Two Monte Carlo codes for calculation of dose in homogeneous or Snyder-type inhomogeneous phantoms are presented. The calculation method and the possible choices of the phantom and external photon source are described. The input list and other notes for users are included. To save computer time a special method for estimation of the standard deviation is used. The codes can be applied to various problems in health physics and dosimetry; such as burden of medical x-ray application, irradiation from radioactive sources or accidental overexposure. (auth)

32415 (ORNL-TM-3329) NEUTRON DEPTH DOSE DISTRIBUTIONS IN HETEROGENEOUS PHANTOMS. Poston, John W. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 127p. Dep. NTIS.

Thesis. Submitted to Georgia Inst. of Tech., Atlanta.

A study for establishing neutron dose distributions at bone-tissue interfaces in the human body is reported. Similar measurements performed for photons of up to 200 keV have shown a reduction in the dose delivered to tissue areas shielded by bone of up to a factor of two. The design and operational characteristics of extrapolation ionization chambers intended to measure analogous distributions due to fast neutrons are described. Measured distributions due to fission spectrum and 14-MeV neutrons are presented and discussed. Results from measurements with fission spectrum neutrons indicate that the high voltage electrodes attached to the front of the detectors were too thick to allow the measurement of the changes in dose distributions very near the interface. However, distributions due to 14-MeV neutrons indicate a reduction in the predicted homogeneous depth dose distribution due to the presence of bone. The reduction is about 20% at a distance in bone of about 2 cm. In tissue at the rear of bone, a buildup or increase in the dose deposited has been demonstrated which is about 50% more than the interface value at a depth in tissue of 0.8 to 1.0 cm. These results are discussed and compared with available theoretical descriptions. Also included is a discussion of the problems associated with the use of these detectors, a discussion of the sources of error in the experiment, and a set of recommendations for improvement and further study in this area. (118 references) (auth)

32416 (ORNL-TM-3398) FORTRAN PROGRAM FOR GAMMA-RADIATION DOSIMETRY FOR ARBITRARY SOURCE AND TARGET GEOMETRY. Hubbard, Lincoln B. (Oak Ridge National Lab., Tenn.). 29 Apr 1971. Contract W-7405-eng-26. 21p. Dep. NTIS.

The program DOSE1 calculates the first collision dose for gamma rays in arbitrary finite geometry of source, absorber, and target. The basic unit of the program is the subroutine ATINTG which calculates the attenuation term exp $(-\int_{r_1}^{r_2} \mu(r)\, dr)$ where the line integral is taken along the straight line path from r_1 to r_2. The total volume, including both source and target, is subdivided into small rectangular parallelepipeds. The absorption is calculated as exponential, $e^{-\mu x}$, for each elementary volume traversed from the source volume to the target volume. The contributions from all sources are summed to give point-specific absorbed fractions for each elementary volume. The total absorbed fraction is the average of the point functions. The approach used differs markedly from the current dosimetry procedure using the Monte-Carlo method. (auth)

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32417 (ORNL-tr-2460) DOSAGE CHARACTERISTICS OF 200-MeV PROTONS. Zel'chinskii, M.; Pshona, S.; Komochkov, M. M.; Sychev, V. S.; Cherevatenko, A. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). Translated for Oak Ridge National Lab., Tenn., from report JINR-P16-5383. 9p. Dep. NTIS.

Previously abstracted from the Russian as Nuclear Science Abstracts 25, 11054. (D.D.D.)

32418 CALCULATION OF DEPTH DOSES OF ^{60}Co RADIATION IN DISTAL IRRADIATION THROUGH A GRID. Barkova, A. M. (Leningrad Inst. for Graduate Medical Studies). Med. Radiol.; 16: No. 2, 67-71(Feb 1971). (In Russian).

A method for calculating percentage depth doses in tissues from external irradiation through a lead grid is proposed. In the calculation data are used on the tissue-air ratio for ^{60}Co γ radiation. Formulas for calculation of the dose under the open and closed areas of the grid are given. The results of the calculation were compared with data from experimental measurements obtained with the aid of a thermofluorescent dosimeter. A satisfactory correlation of calculated and experimental values of doses under the open areas of the grid was found. (auth)

32419 DEPTH-DOSE CURVES FOR α PARTICLES FROM AREA SOURCES AND POINT SOURCES. Walsh, Philip J.; McRee, Donald I. (National Inst. of Environmental Health Sciences, Research Triangle Park, N. C.). Health Phys.; 20: 352-3(Mar 1971).

A common expression for dose rate at a known depth of penetration from both an area source and from a point source is derived. It is apparent from the discussion that the difference in dose delivery between these two sources is contained in A, the expression for the activity per particle in the one case, and for the activity per unit surface area in the other. Determination of A for both cases is discussed. (UK)

32420 NEUTRON DOSE, DOSE EQUIVALENT, AND LINEAR ENERGY TRANSFER FROM ^{252}Cf SOURCES. Jones, T. D.; Auxier, J. A. (Oak Ridge National Lab., Tenn.). Health Phys.; 20: 253-8(Mar 1971).

The distributions of absorbed dose, dose equivalent, and linear energy transfer in cylindrical phantoms irradiated by neutrons from the spontaneous fission of ^{252}Cf were calculated. Monte-Carlo techniques were used to compute these distributions for broad and collimated beams of neutrons. The slopes of the absorbed dose curves for all protons and positive ions and for neutron-generated γ rays closely approximate those for sources of 5 MeV and 2.5 MeV neutrons, respectively. All of the major structure in the distributions of linear energy transfer is readily resolved in these calculations. (auth) (UK)

32421 INFLUENCE OF INCIDENCE ANGLE OF MONOENERGETIC NEUTRONS ON DOSE EQUIVALENT DISTRIBUTION FOR RECOIL NUCLEI IN MAN'S PHANTOM. Zolotukhin, V. G. (Inst. of Physics and Engineering, Obninsk, USSR); Obaturov, G. M.; Prokof'eva, Z. A.; (and others). Health Phys.; 20: 205-12 (Feb 1971).

At present, normalization of neutron human exposure is based on Snyder and Neufeld's calculated results. However the approximations used by them do not sufficiently approximate the real conditions of human exposure. In this paper distribution of the dose equivalent due to recoil nuclei of monoenergetic neutrons of energies from 100 eV to 10 MeV in a tissue equivalent man-size phantom was determined by a Monte Carlo technique. The dose equivalent distributions along the X and Y axes for eight directions of the incident neutron beam on the phantom are given. (auth) (UK)

32422 RADIATION FIELD AND ISODOSES OF A ^{113}Sn/^{113m}In GENERATOR AND ITS INDIUM ELUATE. Grebe, Siegfried Franz; Roemer, Manfred; Lichy, Duchan; Dietzel, Franz (Justus-Liebig Univ., Giessen, Ger.). Strahlentherapie; 140: 448-51(Oct 1970). (In German).

The radiation field and isodoses of a 25 mCi ^{113}Sn/^{113m}In generator and its indium eluate were measured for different working conditions and with different protection barriers. The dose was also measured at various distances in the liver, after injection of a microparticle suspension of indium, which mainly accumulated in the liver. Exposure-rate peaks occurred at the fingers during the manipulations. The relatively high amount of beta radiation was non-negligible dose for the patient, in spite of its short half-life. (auth)

32423 TIME OF COUNTING AND VALUE OF SORTING IN HUMAN SPECTROMETRY. Frossard, H.; Andrieu, L.; Perles, R.; Fabre, J.; Fernet, P.; Prat, G. (Centre de Recherches du Service de Sante des Armees, Clamart, France). Radioprotection; 4: 217-28(1969). (In French).

A statistical study made on two groups of installations for human γ spectrometry showed that the reduction of the counting time from 10 to 2 min. for spectrometric examinations does not decrease significantly the statistical precision of these examinations. Therefore routine surveillance can be made by a three-detector 2-minute examination. The non-contamination of the subject can be established by the calculation of a sorting index and the establishment of a spectrum. (tr-auth)

32424 ESTIMATES OF POTENTIAL DOSES TO VARIOUS ORGANS FROM X RADIATION EMISSIONS FROM COLOR TELEVISION PICTURE TUBES. Neill, Robert H.; Youmans, Harry D.; Wyatt, John L. (Public Health Service, Rockville, Md.). Radiol. Health Data Rep.; 12: 1-6(Jan 1971).

Using the x radiation exposure rates determined in the metropolitan Washington color television survey, doses to various organs of children and adults were calculated. For a television receiver with a picture tube emitting 0.5 mR/h (the maximum exposure rate allowed under the Department of Health, Education, and Welfare performance standards) and with other specified assumptions, the calculated dose to a child ranged from 5 mrem yr to female gonads to 42 mrem yr to skin. For an adult, the doses were 2 mrem yr to 18 mrem yr, respectively. Using the same assumptions but for a picture tube emitting 0.043 mR hr (the average exposure rate observed in the metropolitan Washington survey), the respective doses were 0.4 mrem yr to 3.6 mrem yr for a child and 0.2 mrem yr to 1.6 mrem year for an adult. (auth)

32425 OVARIAN RADIATION DOSAGE DURING HYSTEROSALPINGOGRAPHY. Shirley, Robert L. (Harvard Univ., Boston). Fert. Steril.; 22: 83-5(Feb 1971).

A functional clinical measurement of ovarian radiation dose during hysterosalpingography was performed. With fluoroscopy and spot films the mean radiation dose was about 1000 millirads. By use of the simpler two-film technic the mean dose was found to be 130 millirads. (auth)

32426 CALCULATION OF ABSORBED DOSES IN INTRACAVITARY GAMMATHERAPY OF CANCER OF THE UTERINE CERVIX ACCORDING TO THE PRINCIPLE OF CONSECUTIVE INTRODUCTION OF RADIATION SOURCES. Titova, V. A.; Montuznaya, L. A. (Moscow Research Inst. of Oncology). Med. Radiol.; 16: No. 3, 65-8(Mar 1971). (In Russian).

Data from clinical observations on 100 patients suffering from uterine cervical cancer in the first to third stages were analyzed. The patients were subjected to combined treatment using intracavity γ radiation with consecutive introduction of radioactive sources. A M-20 electronic computer was used for the calculation of absorbed doses, which was done for standard sets of linear ^{60}Co emitters. (tr-auth)

32427 AUTOMATION OF DOSE ANALYSIS IN RADIOTHERAPY. da Rocha, A. F. Goncalves (Fondazione Scuola di Medicina e Chirugia, Rio de Janeiro); Borges, M. Aranha. Minerva Radiol.; 15: 77-85(Mar 1970). (In Italian).

A method for the use of a digital computer in the calculation of the integral dose and the tracing of isodose curves for radiotherapy is presented. (J.S.R.)

Radiation Protection

Refer also to abstract 32201.

32428 (CEA-N-1407) CLIMATIC CONDITIONS OF WORK IN PRESSURIZED SUITS. Chretien, Louis; Le Bourdonnec, Yvon; Werderer, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1971. 45p. (In French). Dep. NTIS (U. S. Sales Only).

The climatic conditions which exist, under different degrees of work, inside a pressurized suit, usually worn at the Centre d'Etudes Nucléaires de Saclay, are described. After a brief review of the physical conditions influencing the gain or loss of metabolic heat from human body, the various relations concerning heat convection and absorption are given, as well as those related to sweat removal. The equations are solved by a graphic method that lead to diagrams which, for a given work situation, and as a function of air flow, give the index of thermal stress. This index indicates the thermal environment to which the wearer is exposed. The diagrams are in agreement with published experimental observations. (France)

32429 DELIMITING THE FIELDS FOR COMPLEX REGION IRRADIATION IN TELECOBALT THERAPY ESPECIALLY FOR HEMOLYMPH DISEASES. Roussel, A.; Abbatucci, J. S.; Quint, R.; Bloquel, J. (Antituberculeux Centre, Caen, France). J. Radiol., Electrol., Med. Nucl.; 50: 254-9(Mar-Apr 1969). (In French).

The principal inconveniences presented by the usual protection by bricks with parallel sides in the realization of regional irradiation fields of complex form, as for example the Kaplan-type mantlet field, are summarized. These include: impossibility of obtaining an ideal contour; difficulty of obtaining a rididly identical protection from one treatment to the next; inevitable addition of a transmission penumbra to the geometric penumbra; time loss; fatigue for personnel; and insecurity for the patient. A new technique with focalized boundary protection of a form adaptable to each case is proposed. It can be easily modified to the proportion of the tumor regression. The dosimetric study made has encouraged its use for all regional irradiations on fields of complex form and particularly in Hodgkin's disease and similar diseases. (tr-auth)

Safety Procedures

Refer also to abstract 34395.

32430 (CEA-CONF-1724) RADIATION PROTECTION IN A REPROCESSING PLANT. STUDY OF THE DIFFERENT SAFETY FACTORS. Peyresblanques, Henri (Commissariat a l'Energie Atomique, Chusclan (France). Centre de Production de Plutonium de Marcoule). 1970. 18p. (In French). (CONF-700930-3). Dep. NTIS (U. S. Sales Only).

From Seminar on radiation protection problems relating to transuranium elements; Karlsruhe, Germany (21 Sep 1970).

In spite of high potential risks, a radiochemical reprocessing plant can be run without danger by respecting safety rules concerning chemicals, fire, and explosions. This implies not only maintaining an integrated radiation dose level as low as possible but also arranging that a human or technical failure cannot lead to serious consequences. However a proper compromise must be found between degree of safety and economic efficiency. The different safety factors at the Marcoule plutonium extraction plant are examined (design of equipment and premises, psychological factor, prevention, and detection of radioactive risks). (France)

32431 (JUL-670-ST) 1969 PROGRESS REPORT OF THE CENTRAL RADIATION PROTECTION DIVISION. Keller, M.; Tzschaschel, R. (eds.) (Kernforschungsanlage, Juelich (West Germany). Zentralabteilung Strahlenschutz). Jul 1970. 272p. (In German). Dep. NTIS (U. S. Sales Only).

The Radiation Protection Division of the Nuclear Research Establishment at Julich, West Germany, is responsible for the radiation protection of personnel, installations, and monitoring of the environment. This includes the introduction of methods and procedures according to the most recent knowledge of science and research. Activities during 1969 are reported. (TSS)

32432 (LFEN-102-b) RESEARCH LABORATORY HEALTH AND SAFETY PROGRAMME. Vaz Carreiro, J. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium). Junta de Energia Nuclear, Sacavem (Portugal). Laboratorio de Fisica e Engenharia Nucleares). 1969. 36p. Dep. NTIS (U. S. Sales Only).

The radiation protection program developed for a plant engaged in the chemical processing of irradiated reactor fuel elements is described. The program covers all safety problems and discusses the duties and responsibilities of personnel. The equipment needed for the radiation monitoring program is described. (C.H.)

32433 AURPO SURVEY OF SAFETY DEVICES ON X RAY CRYSTALLOGRAPHY/DIFFRACTION SETS. Stern, Babette E. (Univ. of Surrey, Eng.). Health Phys.; 20: 358-60(Mar 1971).

Some x-ray sets do not conform to recommended safety standards. It is economically wasteful and often technically unsatisfactory for each user to design and fit his own safety devices, or to modify those which are inadequate. Last year, the Association of University Radiation Protection Officers (British) set up a working party to examine the extent of this problem, and to recommend what, if any, further action might follow. The opportunity was taken to widen the enquiry in order to get a general view of current practice. Some of the current safety recommendations were questioned. (auth) (UK)

32434 FACT AND FICTION ABOUT HEALTH AND ATOMIC POWER PLANTS. Norwood, W. D. (Hanford Environmental Health Foundation, Richland, Wash.). J. Occup. Med.; 13: 199-204(Apr 1971).

The hazards to the safety and health of employees and the public, the present standards of health and safety and their implementation, and the results obtained to date in the operation of nuclear installations, and particularly, the Hanford atomic installation are reviewed. Disposal of radioactive wastes, radionuclide discharges to water and air, and heat discharges to water from nuclear reactors are evaluated and discussed. Some of the fallacies of recent critical reports on the consequences of the use of atomic energy are pointed out. (E.E.H.)

32435 SURVEYS OF RADIUM CONTAMINATION IN AIRCRAFT INSTRUMENT REPAIR FACILITIES 1966-1967. Schmidt, Gail D. (Bureau of Radiological Health, Rockville, Md.); Halperin, Jerome A.; Geiger, Eric; Livingstone, Walter. Radiol. Health Data Rep.; 12: 7-15(Jan 1971).

A survey of 30 aircraft instrument repair facilities revealed many cases of significant radium contamination, resulting from repair and dial stripping operations on radium luminous dial instruments. Five out of 15 facilities surveyed in Wichita, Kans., showed alpha contamination exceeding 200,000 dpm/100 cm^2, with a maximum of 1,650,000 dpm/100 cm^2. The direct gamma radiation ranged from background to 60 mR/h. Whole-body counts of 33 persons working in these facilities showed radium body burdens in two people that were about 40 percent of the maximum permissible body burden. A similar survey of 15 repair facilities in Dade County, Florida, showed lower alpha contamination levels by a factor of 10. Based upon these findings, a radiation control program, including contamination guides, has been recommended for instrument repair facilities. (auth)

Legal Aspects

32436 ITALIAN REGULATIONS ON THE USE OF RADIOACTIVE SUBSTANCES. Com. Naz. Energ. Nucl., Notiz.; 16: 65-9(Jan 1970). (In Italian).

Italian legislation concerning peaceful applications of radioactive materials for various purposes are reviewed. The respective obligations arising from the possession and use of such materials are set forth in Law No. 1860 and subsequent legislation, particularly in the Presidential Decree No. 1704 of December 30, 1965, which regulates in detail the legal aspects of the use of radioactive materials in industry and agriculture, in education and research, in medicine for diagnostic and therapeutical purposes, and in experimental clinical research. Penalties for violations are given. Excluded from these regulations and subject to other control, not discussed in the article, are fissionable materials, radioactive minerals, raw materials, and apparatus for the generation of ionizing radiation. (TSS)

Medicine

Refer also to abstracts 31783, 32351, and 32354.

32437 RADIOPHARMACEUTICALS. Wolf, Walter (Univ. of Southern California, Los Angeles); Balaban, Alexandru T. Int. At. Energy Agency Bull.; 13: No. 1, 13-19(1971).

The use of radioisotopes for diagnosis and therapy in nuclear medicine is outlined. Instruments used in scanning and radioisotope generators are described. Possible developments in the synthesis of new radiopharmaceuticals are discussed. (F.M.M.)

Protective Substances

Refer also to abstracts 31893, 32363, 32387, 32553, 32564, 32593, 32618, 32622, 32625, and 32630.

32438 MECHANISM OF MODIFICATION OF RADIATION EFFECT BY DIMETHYL SULFOXIDE. Hagemann, R. F.; Schaer, J. C. (Allegheny General Hospital, Pittsburgh). Experientia; 27: 319-21(15 Mar 1971).

Earlier studies on in vivo effects of dimethyl sulfoxide (DMSO) revealed a dichotomy-protection in some instances and a sensitization in others. In order to study the in vitro effects of DMSO on a system of mammalian cells, P815X2 mastocytoma cells were used and DMSO in concentrations of 0, 3, and 15% was added before or immediately after x irradiation. When 3% DMSO was added before irradiation, it acted as a radioprotector regardless as to whether it was removed immediately after irradiation or remained during the repair period. An increase in survival was noted at a concentration of 15% if the substance was removed immediately after irradiation; however, a drastic decrease in survival occurred if the substance remained during the repair period. (H.L.W.)

32439 FEATURES PECULIAR TO THE PROTECTIVE EFFECT OF CYSTAPHOS IN FRACTIONAL IRRADIATION OF TRANSPLANTABLE SOLID TUMORS. Kublik, L. N.; Eidus, L. Kh.; Yarmonenko, S. P. (Moscow Inst. of Biological Physics.

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Inst. of Experimental and Clinical Oncology, Moscow). Med. Radiol.; 14: No. 4, 63-7(Apr 1971). (In Russian).

The effectiveness of cystaphos protection of neoplastic cells of M-1 sarcomas following a single radiation dose was demonstrated. A reduction in the protective effect was noted following fractionated doses. (auth)

32440 ROLE OF ANTIRADIATION AGENTS IN THE FORMATION OF THE BIOCHEMICAL BACKGROUND OF RADIORESISTANCE. Goncharenko, E. N. (Moscow State Univ.). Zh. Obshch. Biol.; 32: 13-26(Jan-Feb 1971). (In Russian).

The problem concerning the formation of the biochemical background of radioresistance in the organism under the influence of radioprophylactic substances and hypoxia in organs and tissues is considered. It is suggested that the background of radioresistance may arise as a result of an increase in the content of radioprophylactic endogenous substances (serotonin and histamine) in animal organs and tissues and a decrease in the content of biogenic radiosensitizers (products of oxidation of higher unsaturated fatty acids). This suggestion was experimentally confirmed. The biochemical mechanisms for changes in the content of the biogenic substances studied under the influence of injected radioprotectors are discussed. (auth)

32441 IN-VIVO FIXATION OF ^{35}S β-MERCAPTOETHYLAMINE (^{35}S-MEA) BY PROTEINS OF THE CYTOPLASMA AND OF THE NUCLEUS OF THYMUS CELLS OF THE RAT. Filippovich, I. V.; Zhulanova, Z. I.; Trebenok, Z. A.; Sheremet'evskaya, T. N.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Dokl. Akad. Nauk SSSR; 195: 225-8(1 Nov 1970). (In Russian).

Previous observations indicated that the highest accumulation of radioprotective MEA, administered intraperitoneally, occurred within 15 to 30 min and coincided with the period of maximum effectiveness of the agent. The fixation of MEA by the proteins of the cytoplasma and the nucleus of the thymus cells was investigated. The experiments were carried out with white rats injected with ^{35}S-labeled MEA. The ^{35}S-MEA HCl was administered at a dose rate of 150 mg/kg, and the rats were sacrificed 3, 15, 30, and 60 min after injection. The compound dithioerytrite was used to split the mixed disulfide bonds of MEA. Measurement of the radioactivity before and after the treatment made it possible to distinguish between the fixation of MEA by the proteins and by disulfide bonds. The results indicated that the thymus retains the largest amount of the radioprotectors by disulfide bonds at the time interval when the highest protective efficiency was noted. The introduction of MEA coincided with the maximum inhibition of the formation of DNA precursors (thymidine kinase and deoxyribose transfer systems). The temporary inhibition of radiosensitive biochemical reactions may be attributed to the formation of mixed disulfides between the protective agent and the ferments. (TTT)

32442 DECREASE OF THE ENDOGENOUS RADIOSENSITIZER LIPOID TOXICANTS AS ONE OF THE MECHANISMS OF THE RADIOPROTECTIVE EFFECT. Kudryashov, Yu. B.; Goncharenko, E. N.; Deev, L. I.; Gorskaya, T. G.; Samoilikova, T. I. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 195: 206-8(1 Nov 1970). (In Russian).

The radioprotective mechanism involving the formation of biogenic amines and the decrease of lipoid toxicant radiosensitizers was studied while investigating the biologically active materials in the tissues of animals under the influence of radioprotectors. The protective effect was evaluated on the basis of the reduction of the $LD_{50/30}$ factor in animals treated with mercaptoethylamine (MEA), aminoethylisothiouronium (AET), serotonin creatinin sulfate (5-NT); serine, methoxy tryptamine, (6-MOT), or an 0.85% NaCl solution was used for control. The materials were introduced intraperitoneally before exposing the animals to radiation doses ranging from 400 to 1400 rad. In order to establish hypoxia, the air pressure was reduced to 230 mm of Hg. The radioprotective efficiency was also examined on the basis of the lowering of the oxidation-reduction potential which was measured by means of a subcutaneous needle electrode. The results indicated that one of the potential action mechanisms of radioprotective agents involves the lowering of biogenic radiosensitizer content during the period of increased radiation resistance as a result of hypoxia or the administration of radioprotectors. (TTT)

32443 EFFECTS OF O-(β-HYDROXYETHYL)-RUTOSID (HR) ON RADIOSENSITIVITY OF INTESTINAL CAPILLARIES. Braun, Hildegard (Univ., Freiburg i. B.). Strahlentherapie; 140: 533-9(Nov 1970). (In German).

The modifications induced by whole-body irradiation of 800 R in the capillaries of the duodenal mucosa of albino mice were studied using the electron microscope. After a few hours, an increase in cytopempsis was observed; later multiple cytoplasmatic outgrowths and intercellular junctions were found. The basal membrane was disjunct from the endothelial cells. These modifications were much less apparent after administration of O-(β-hydroxy-ethyl)-rutosid (HR). The basal membrane did not disjunct. The increased cytopempsis was not modified. The HR flavanoid did not modify the radioinduced decrease in the number of mitoses in the crypt cells. However, it favorably influenced the regeneration. (auth)

32444 INVESTIGATIONS ABOUT X-RADIOPROTECTIVE EFFECTS OF HYPOTHERMIA IN RATS. Brunner, J.; Fochem, K.; Michalica, W.; Picha, E. (Univ., Vienna). Strahlentherapie; 140: 553-6(Nov 1970). (In German).

Various organs of 30 rats were studied histologically after whole-body irradiation of 1200 R in hypothermia. Sections were made after different time intervals. A clear protective effect was found. The lesions within the liver and the spleen were fewer and remained for a shorter time than in rats irradiated under normal conditions. (auth)

32445 SEARCH FOR RADIOPROTECTIVE AGENTS. PART XXII. SYNTHESES OF SOME SULFUR DERIVATIVES OF 2,4-DIMETHOXY-6-AMINOPYRIMIDINE AND 2-AMINOPYRIMIDINE. Tulecki, Jerzy; Musial, Eugeniusz (Medical Academy, Poznan, Poland). Diss. Pharm. Pharmacol.; 23: 41-7(Jan-Feb 1971).

The synthesis of the following radioprotective compounds is described: disulfides of bis (β-(2,4-dimethoxy-6-pyrimidylamino)-ethyl), bis-(β-(2πpyrimidylamino)-ethyl), and bis-(β-(2-pyrimidylamino)-ethyl) dihydrochloride, and 2,4-dimethoxy-6- and 2-(2'-nitrophenyldithio)-pyrimidine. (auth)

32446 INVESTIGATIONS ON THE EFFECTS OF RADIOPROTECTIVE SH-BINDING SUBSTANCES ON THE IRRADIATED THYMUS. Braun, Hildegard; Albach, Wolf-Dieter (Univ., Freiburg i. B.). Strahlentherapie; 140: 433-41(Oct 1970). (In German).

The effects of cysteine and cysteamine, two radioprotectors on the thymus of irradiated animals were studied. These two compounds had no influence on the weight loss of the thymus due to the irradiation. In the protected animals there was however a more rapid increase of the weight. Eight hrs after irradiation, the number of pycnotic lymphocytes in the protected animals was much lower than in the irradiated unprotected controls. The weight loss of the thymus of protected animals was due to an increased output of lymphocytes. The motility of the cells of treated animals was indeed preserved. The number of reticulum cells increased in the treated animals immediately after irradiation. The radioprotector cysteine and cysteamine and the radiosensitizer isocysteine had the same influence on the thymus of non-irradiated animals. A direct relation between the activation of the reticulum and the increase of the radioresistance could not be demonstrated. (auth)

32447 EFFECTS OF CHEMOTHERAPEUTIC AGENTS ON THE RNA METABOLISM OF ^{90}Sr-INDUCED RAT CHLOROLEUKEMIA. Nakai, George S.; Guganig, Marlene E. (Univ. of New Mexico, Albuquerque). Proc. Soc. Exp. Biol. Med.; 136: 1374-9(Apr 1971).

The metabolism of nuclear and cytoplasmic ribonucleic acid (RNA) of a ^{90}Sr-induced rat chloroleukemia was characterized and the effects of chemotherapeutic agents on this RNA metabolism studied. The in vitro ^{3}H-uridine incorporation into nuclear and cytoplasmic RNA of this tumor is inhibited by certain chemotherapeutic agents. The following chemotherapeutic agents were studied: vinblastine sulfate; polyinosinic–polycytidylic acid; L-asparaginase; cytosine arabinoside; Daunomycin; hydrocortisone; 6-methylmercaptopurine ribonucleoside; DL-threonine (utilized as a serine antagonist). In general, the chemotherapeutic agents tested appeared to interfere with ^{3}H-uridine incorporation into cytoplasmic and nuclear RNA. Preliminary evidence suggests poor correlation between in vivo destruction of tumor and in vitro ^{3}H-uridine incorporation into nuclear or cytoplasmic RNA with vinblastine sulfate, L-asparaginase, and polyinosinic–polycytidylic acid. (auth)

32448 EFFECTS OF CHELATING AGENTS (IMINODIACETATE DERIVATIVES OF THE OXYTRIPHENYLMETHANE SERIES) ON THE BEHAVIOR OF ^{59}Fe, ^{65}Zn, ^{90}Sr, ^{91}Y, AND ^{144}Ce IN THE BODY. Voronina, N. M.; Tregubenko, I. P.; Latosh, N. I.; Sukhacheva, E. I.; Semenov, D. I. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 68-75(1970). (In Russian).

The effects of chelating agents (iminodiacetate derivatives of the oxytriphenylmethane series) on the tissue deposition and excretion from the body of radioisotopes of Fe, Zn, Sr, Y, and Ce were studied. A difference in their action was established based on structural peculiarities of the agents and on the number of iminodiacetate molecules in their structure. (tr-auth)

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32449 EFFECTS OF CHELATING AGENTS (OXY- AND SULFO-SUBSTITUTED EDTA AND IMINODIACETIC ACIDS) ON THE BEHAVIOR OF ^{144}Ce IN THE BODY. Podgornaya, I. V.; Latosh, N. I.; Tregubenko, I. P.; Semenov, D. I. Tr. Inst. Ekol. Rast. Zhivotn.; No. 68, 76-80(1970). (In Russian).

The effects of the introduction of oxy- and sulfo- groups into the molecules of chelating agents on their capacity to enhance the excretion of ^{144}Ce and to prevent its deposition in tissues were studied. It was established that the efficiency of the chelating agents was increased by the introduction of one or two oxy- groups to the molecule. The addition of sulfo- groups, on the other hand, decreased the efficiency of the agents. (tr-auth)

32450 EFFECTS OF RADIOPROTECTIVE AMINOTHIOLS IN VIVO ON THE SEDIMENTABILITY OF MITOCHONDRIA. Thomson, John F.; Nance, Sharron L.; Tollaksen, Sandra L. (Argonne National Lab., Ill.). Radiat. Res.; 45: 629-44(Mar 1971).

The sedimentation characteristics of mitochondria from livers of mice treated with various radioprotective aminothiols were measured by techniques of density-gradient and zonal centrifugation. Treatment with cysteine, MEA, or the phosphorothioate of MEA caused the mitochondria to sediment more slowly; AET caused them to sediment more rapidly. Other compounds had no significant effect. These changes were interpreted as the result of either swelling or contraction of the mitochondrial outer membranes. None of the compounds that affected liver mitochondria had any effect on the sedimentability of mitochondria isolated from Ehrlich ascites tumor cells that had been incubated with those compounds. (auth)

32451 CYTOLOGICAL STUDY OF BONE MARROW AND PERIPHERAL BLOOD OF IRRADIATED AND NONIRRADIATED MICE TREATED WITH 19S ALPHA-2 GLOBULIN (α_2-MG). Sontag, J. M.; Berenblum, I.; Trainin, N. (Weizmann Inst. of Science, Rehovot, Israel). Radiat. Res.; 45: 511-21(Mar 1971).

A cytological study was made of the bone marrow and peripheral blood of irradiated and nonirradiated mice treated with 19S alpha-2 globulin (α_2-MG). Granulocytosis was the immediate result of the α_2-MG treatment in both the irradiated and nonirradiated animals. The bone marrow from the α_2-MG injected nonirradiated mice showed an early and pronounced elevation in the number of lymphocytes and lymphocyte-like cells and a subsequent granulopoiesis. The α_2-MG injected irradiated mice had an enhanced recovery, in both time and magnitude, of the granuloid and lymphocyte and lymphocyte-like elements of the bone marrow, as well as of the leukocytes of the peripheral blood. (auth)

32452 QUANTITATIVE ANALYSIS OF BONE MARROW CELL POPULATIONS IN IRRADIATED AND NONIRRADIATED MICE TREATED WITH 19S ALPHA-2 GLOBULIN (α_2-MG). Sontag, J. M.; Trainin, N.; Berenblum, I. (Weizmann Inst. of Science, Rehovot, Israel). Radiat. Res.; 45: 499-510(Mar 1971).

A quantitative study was made of the effects of 19S alpha-2 globulin (α_2-MG) on the total cellularity and cell populations, according to cell volume, of the bone marrow from normal and irradiated mice as compared to similar measurements made in control animals. An electrical device, based on the Coulter counter principle, was used as a rapid means of effecting these measurements. In the bone marrow from normal untreated mice, it was possible to discriminate between three major populations of cells. The first population contained cells between the volumes of 10 to 107 μ^3, the second between 108 to 214 μ^3, and the third between 215 to 425 μ^3. Following α_2-MG treatment, the bone marrow from nonirradiated mice showed significant alterations in their cell populations. Particularly striking were the concomitant, but inverse, changes in the first and third populations. Following the last exposure, the second and third populations of the bone marrow from the irradiated mice were severely depressed. Alpha-2 macroglobulin treatment of these animals appeared to stimulate recovery of the third population and enhance the bone marrow's return to normalcy. (auth)

32453 PRUSSIAN BLUE AS A PREVENTIVE MEASURE IN CHRONIC INTAKE OF ^{137}Cs AND ^{90}Sr IN THE FOOD RATION. Danetskaya, E. V.; Korzun, V. N.; Ramzaev, P. V.; Shakalova, V. V. (Leningrad Inst. of Radiation Protection). Gig. Sanit.; No. 12, 36-40(Dec 1970). (In Russian).

Addition to the food ration of albino rats, that were poisoned with a mixture of ^{137}Cs and ^{90}Sr, of Prussian blue in a dose of 100 mg a day for a period of 500 days brought about a stable fall in the accumulation of ^{137}Cs (by 98%) and of ^{90}Sr (by 22%). However estimation of the specific activity of excretions showed Prussian blue to decrease the adsorption dose of ^{137}Cs almost 20 times and to increase its dose to the large intestine 5 times. Consequently, the prophylactic use of Prussian blue in case of chronic intake of ^{137}Cs and ^{90}Sr in the food ration cannot be recommended for the lack of sufficient experimental substantiation. (auth)

32454 RADIOPROTECTIVE PROPERTIES OF THE DIBROMHYDRATE OF BIS(2-AMINOETHYL)DISULFIDE IN THE RANGE OF LONG-WAVE X RAYS. Kuznetsova, L. A.; Rybakov, N. I.; Frolova, A. V.; Kolotilova, V. G. (Moscow Research Inst. of X-ray Radiology). Med. Radiol.; 15: No. 12, 7-11(Dec 1970). (In Russian).

The numerical importance of the factor of dose reduction of dihydrogen bromide of 2,2'-dithiobisethylamine was determined. Determination of this factor in x irradiation of a lysogenic bacterial culture with consideration of its quantitative composition is an experimental substantiation for conducting such investigations on different biological organizations for elucidating the possibility of using this radioprotector during radiotherapy. (auth)

32455 INFLUENCE OF PROTEIN CONTENT ON ^{137}Cs INCORPORATION AND RESISTANCE OF THE ORGANISM TO CHRONIC INTERNAL IRRADIATION. Danetskaya, E. V.; Ershova, V. P.; Ushakova, A. P.; Shakalova, V. V. (Leningrad Research Inst. of Radioprotection). Med. Radiol.; 15: No. 12, 25-30(Dec 1970). (In Russian).

The influence of the quantitative content of protein in the diet on ^{137}Cs incorporation and resistance of 500 male albino rats to internal irradiation was studied. The presence of a reverse correlation between the protein content in the diet and value of ^{137}Cs in the tissues and a direct correlation between the protein level in the diet and rate of ^{137}Cs elimination were established. Investigations on the morphological composition of the blood and a number of biochemical indexes showed that the organism's resistance to the injurious effect of chronic internal irradiation increased if the animals received a protein-rich diet. (auth)

32456 COMPARISON OF THE EFFECTS OF SOME IODINE COMPOUNDS ON THE SURVIVAL OF ESCHERICHIA COLI B/r IRRADIATED WITH X RAYS AND ULTRA-VIOLET LIGHT. Sapora, Orazio. Ann. Ist. Super. Sanita; 6: 293-301(1970).

Iodine compounds, which enhance the response of some biological systems to ionizing radiation, were studied for their influence on survival of uv irradiated Escherichia coli B/r. It was found that non-toxic concentrations of sodium iodide, iodoacetic acid, iodopropionic acid, and iodoacetamide protect microorganisms against the lethal effects of uv light. The protection afforded was greater for bacteria in stationary phase than for those in mid log phase, and appeared to be correlated with the absorption of iodine compounds at 254 nm. (auth)

32457 THERAPEUTIC EFFECT OF 2-AMINO-4-HYDROXY-6-(1',2',3',4'-TETRAHYDROXYBUTYL)-5,6,7,8-TETRAHYDROPTERIDINE IN X-IRRADIATED MICE. Sonka, J.; Slavik, K.; Strakova, M.; Cihar, R. (Charles Univ., Prague). Radiat. Res.; 45: 536-41(Mar 1971).

The survival of x-irradiated mice was studied after the administration of synthesized 2-amino-4-hydroxy-6-(1',2',3',4'-tetrahydroxybutyl) pteridine (BP) and its hydrogenated form 2-amino-4-hydroxy-6-(1',2',3',4'-tetrahydroxybutyl)-5,6,7,8-tetrahydropteridine (BPH_4). A single dose of BP or BPH_4 (0.5 mg) was injected ip 5 to 10 minutes after whole-body irradiation (700 R). In comparison with the irradiated and nontreated controls, BPH_4 reduced the mortality to 71% (observed 30 days after irradiation). BP was ineffective in similar conditions. These results are discussed in connection with a similar effect of tetrahydrofolate and some of its derivatives. It seems that tetrahydrofolate and BPH_4 may participate in some redox processes in the tissues of irradiated animals and perhaps counteract the oxidative effects of products formed by irradiation. (auth)

32458 CHEMICAL RADIATION PROTECTION IN MAN AS REVEALED BY CHROMOSOME ABERRATIONS IN PERIPHERAL LYMPHOCYTES. Tanaka, Yoshimasa (Tenri Hospital, Japan); Sugahara, Tsutomu. J. Radiat. Res.; 11: 166-8(Sep-Dec 1970).

Patients with cervical carcinoma were followed during and after radiotherapy to determine the incidence of chromosome aberrations in peripheral lymphocytes. In patients treated with adrenochrome monoguanylhydrazone methansulfonate (100 mg) before every irradiation the incidence was significantly lower than in those without the treatment. The results indicate chemical protection in man for the first time. (auth)

32459 BROMODEOXYURIDINE SENSITIZATION OF THE ULTRAVIOLET-SENSITIVE ESCHERICHIA COLI RAS$^-$ MUTANT TO ULTRAVIOLET IRRADIATION. Lentzen, Donald E.; Walker, James R. (Univ. of Texas, Austin). Mol. Gen. Genet.; 108: 218-24(16 Oct 1970).

Escherichia coli ras$^-$ mutant was sensitized to uv by bromo-

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deoxyuridine. The extent of sensitization indicates that the ras⁻ mutation probably increases uv-sensitivity by an effect on excision repair. This effect probably is uncontrolled degradation without concomitant resynthesis in a small proportion of the repair events. (auth)

Radiation Sickness and Injuries

Refer also to abstracts 32393 and 32566.

32460 IMPORTANCE OF BIOCHEMICAL INVESTIGATIONS IN RADIATION LESIONS IN MAN. Gus'kova, A. K.; Sadchikova, E. N.; Orlyanskaya, R. L. (Moscow Inst. of Industrial Hygiene and Occupational Diseases). Med. Radiol.; 14: No. 4, 52-9(Apr 1971). (In Russian).

On the basis of literature data the importance of biochemical investigations in different forms of radiation sickness in man is discussed as well as the possibility of using them for determining the indications and as a criterion of the effectiveness of treatment. The results of analysis are grouped in four tables characterizing the optimal periods, the most adequate tests and the possible importance of the deviations revealed in the lesions of the muscular tissue and liver, the effect of osteotropic isotopes, and acute radiation sickness within the range of median lethal doses. (auth)

32461 MATHEMATICAL MODEL OF RADIATION INJURY FOR THE USE ON EXPERIMENTAL DATA IN MAN. Zherbin, E. A.; Zherdin, B. N.; Besyadovskii, R. A.; Ivanov, K. V. Med. Radiol.; 15: No. 12, 42-4(Dec 1970). (In Russian).

A stochastic model of radiation injuries using the normal function of distribution is presented, which enables extrapolation of experimental data on animals to humans in radiobiological studies based on general and typical relations of radiation injury distributions as a function of the degree of its gravity. (R.V.J.)

32462 CEREBRAL CIRCULATION IN MAN FOLLOWING SUSTAINED ACUTE RADIATION INJURY. Glazunov, I. S.; Grafov, A. A.; Ivanov, V. A.; Bryzhakhin, G. V. Med. Radiol.; 16: No. 3, 53-9(Mar 1971). (In Russian).

In 10 patients who were exposed to the action of γ rays and neutrons in a total dose of 270 to 980 rem, the state of the cerebral circulation at remote periods of the disease, 5 to 12 yrs after irradiation was studied by means of rheoencephalography and orbital plethysmography. The results showed that at a remote period after acute radiation sickness there was an increase in the adhesive elastic properties of cerebral vessels with the subsequent development of chronic vascular cerebral insufficiency. In the neurological state of patients, there appeared persistent cerebral disorders, headache, vertigo of oculovestibular character, etc., as well as symptoms of microorganic affection of the central nervous system, nystagmus, reflexes of oral automatism, mild pyramidal insufficiency. In general, the data obtained may be considered as signs of premature aging of the organism occurring after acute radiation sickness. Acceleration of involutive processes was confirmed by such clinical manifestations as sclerosing of crystalline lenses with the development of radiation cataract, the presence of trophic skin disorders, a sharp decline of libido, and early greying of the hair. (auth)

32463 EFFECT OF PRODUCTS OF ERYTHROCYTE DESTRUCTION ON THE BLOOD COAGULATION PROCESS IN ACUTE RADIATION SICKNESS. Martirosov, K. S. (Leningrad Military Medical Academy). Probl. Gematol. Pereliv. Krovi; 16: No. 5, 37-41(May 1971). (In Russian).

A study was made of certain blood coagulation indexes in dogs with acute radiation sickness, which occurred under the effect of a hemolysate. The data obtained pointed to the presence in erythrocytes of substances capable of improving the coagulation process in acute radiation sickness. It was considered expedient to carry out research on creation of a therapeutic preparation from erythrocytes without the side effect characteristic of a hemolysate. (auth)

Radiodiagnosis

Refer also to abstracts 32235, 32236–32242, 32244, 32245, 32343, 32422, 32425, 32610, and 32611.

32464 RADIOACTIVITY MEASUREMENTS FOLLOWING INCORPORATION OF ^{99}Tc INTO BRAIN TUMORS WITH RESPECT TO DIFFERENTIAL DIAGNOSIS. Hirschbiegel, Horst; Schwieger, Gunnar (Univ., Dusseldorf). Strahlentherapie; 140: 499-507 (Nov 1970). (In German).

In 100 patients with suspected intracerebral tumor, the radioactivity was followed after administration of ^{99m}Tc. In 42 cases, histologic confirmation was obtained. A radioactivity curve expressed in per cent-values was established. These curves were different for meningiomas and metastases on one side, and for glioblastomas and astrocytomas on the other side, when compared to oligodendrogliomas. Astrocytomas could not be distinguished from glioblastomas. This might be due to the fact that astrocytomas were histologically placed as grade 3 or 4. There was also no distinction between meningiomas and metastases. (auth)

32465 RESULTS OF KIDNEY EXAMINATIONS BY NUCLEAR MEDICAL METHODS FOLLOWING THERAPEUTIC RADIATION DOSES TO PARENCHYMA OF MALIGNANT KIDNEYS. Woellgens, P.; Albrecht, H. J.; Petschen, I. (Univ., Zurich. Kantonsspital, Zurich). Fortsch. Geb. Roentgenstr. Nuklearmed.; 114: 415-21(Mar 1971). (In German).

With the aid of such nuclear medicine examination methods as renal scintigraphy, radionephrography, tubular and glomerular clearance determination, and percentile calculation of the individual kidney performances by the tubular total clearance, radioinduced parenchyma damage can be exactly identified and quantitatively determined. The test results make a new approach to the risks of radionephritis possible. In cured or temporarily cured malignancy patients, radionephritis presents a bearable risk and can be quantitatively determined by the calculation of the dosage-dependent, percentile reduction of renal function. (auth)

32466 CONTRIBUTION TO WORKING TECHNIQUES OF TOTAL-ANIMAL AUTORADIOGRAPHY. Buchtela, Karl; Hackl, Hans (Atominstitut, Vienna. Psychiatrische Krankenhauses, Vienna). Strahlentherapie; 140: 600-4(Nov 1970). (In German).

Because of the clear representation of distribution and content of tissues in whole-body autoradiography of animals, it is a very useful experimental device for examinations of metabolism necessary for the study of newly developed medications. Whole-body animal autoradiography can be carried out in medical laboratories with few experimental difficulties and at a reasonable cost. Chemographic and radioactive contamination can be completely controlled by proper protective measures. (auth)

32467 PROCESS OF IMPROVING THE YIELDS OF RADIOACTIVE FLUORESCEIN. Ratusky, J.; Kronrad, L.; Malek, P.; Vavrejn, B.; Kolc, J. Canadian Patent 865,137. 2 Mar 1971. Priority date 11 Dec 1967, Czechoslovakia.

The yield of radioactive fluorescein compounds obtained by reacting fluorescein or one of its derivatives with a radioactive Hg isotope is improved by adding to the crude mixture obtained from the above reaction the corresponding chemically pure nonradioactive fluorescein compound. An exchange reaction occurs between the nonradioactive and the radioactive fluorescein compounds and provides an increased concentration of radioactive fluorescein compounds with a decreased radioactivity in the final composition. Highly pure compounds of this type are used as medical tracers, particularly for discovering the focus of an infarction. (F.S.A.) (Canada)

32468 METHODS OF OBTAINING ROENTGEN-SCANNOGRAPHIC IMAGES. Gleizer, Yu. Ya.; Zubovskii, G. A.; Soskin, A. M.; Frenkel, V. Kh. (Moscow Research X-ray Radiological Inst.). Med. Radiol.; 15: No. 12, 35-8(Dec 1970). (In Russian).

Superposition methods for obtaining a roentgen-scannographic image in some diseases of internal organs are described. Scanning of organs on the electroroentgenogram and diaprojection superposition of the scannographic images of different organs with review of roentgenocontrast pictures of the same organs are recommended. The diagnostic value of the methods proposed is demonstrated. (auth)

32469 CENTRAL NERVOUS SYSTEM INVESTIGATION WITH RADIONUCLIDES. Second Annual Nuclear Medicine Seminar, Miami, Florida, March 19–23, 1970. Gilson, Albert J.; Smoak III, William M. (eds.). Springfield, Ill.; Charles C Thomas, Publisher (1971). 428p. $27.50. (CONF-700338).

Separate abstracts were prepared for 24 of the 39 papers appearing in this conference. The remaining 15 papers contain information on: brain metabolism; the blood-brain barrier concept; the history of tracers in cerebral spinal fluid studies; the central nervous system; multicrystal and mosaic high speed cameras; the uses, limitations, and hazards of neurological diagnostic techniques; blood-brain barrier; cerebrospinal fluid and cerebral blood flow studies; and cerebral occlusive diseases. (E.E.H.)

For abstracts of individual papers see: 32242–32245, 32343, 32470–32487, and 33922.

32470 RADIOBIOLOGIC PROBLEMS IN THE INVESTIGATION OF THE CENTRAL NERVOUS SYSTEM WITH LABELED

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COMPOUNDS. Sternberg, Joseph (Univ. of Montreal). pp 67-92 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Radiobiologic problems raised by the use of radionuclides in the study of the central nervous system deal chiefly with the damage produced by ionizing radiation to the brain. The functional and morphological changes depend on the amount of radiation, its physical characteristics, route of administration, and age of the animal. The problems involved and the precautions that should be taken in the administration of radionuclides to pregnant females are given. The elements or compounds that are freely transferred by the placenta are described as well as those that remain in the maternal compartments. It was noted that animals showed a significant mammary secretion of ^{203}Hg or ^{197m}Hg chlormerodrin following the use of these compounds for brain scanning. (E.E.H.)

32471 GENERATOR-PRODUCED RADIOPHARMACEUTICALS. Witcofski, Richard L. (Bowman Gray School of Medicine, Winston-Salem, N. C.); Gnau, Thomas. pp 103-124 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

A review is presented on the properties and products of radionuclide generators. The preparation of compounds from these generator-produced radionuclides is illustrated. The biological characteristics and radiation dose to organs from intravenous administration of radiopharmaceuticals are given. The performance of ^{99m}Tc-pertechnetate, ^{99m}Tc-Fe complexes, ^{99m}Tc-DTPA, and ^{113m}Indium-DTPA for use in brain scanning for diagnosis of tumors was compared, along with the advantages and disadvantages of ^{68}Ga-EDTA. The application of ^{99m}Tc-inulin and ^{99m}Tc-albumin to cisternography is also described and compared. The uses of ultrashort half-life generator-produced radiopharmaceuticals are discussed briefly. (E.E.H.)

32472 RADIOACTIVE GASES FOR STUDIES OF THE BRAIN. Wagner, Henry N. Jr. (John Hopkins Hospital, Baltimore). pp 125-35 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The principles involved and the history of the use of gases in the study of cerebral blood flow are reviewed. Since 1963, most studies employing radioactive gases have been done with ^{133}Xe rather than ^{85}Kr but some work is presently being done with ^{15}O. These radioactive gas studies are useful when there is an acute change in the cerebral blood flow such as is produced by anesthesia or hyperventilation. Diffusible indicators measure relative blood flow, blood flow per unit volume, rather than absolute blood flow in ml/min. One disadvantage of the use of these gases is that they require intra-arterial injection via the internal carotid or common carotid artery or they require deconvolution of breath curves. (E.E.H.)

32473 CYCLOTRON PRODUCED RADIOPHARMACEUTICALS: PREPARATION. Hupf, Homer (Univ. of Miami, Fla.). pp 140-7 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The preparation of radiopharmaceuticals from cyclotron targets is described and various plant facilities are illustrated. The cyclotron-produced radionuclides that have been used for brain tumor detection are listed with their labeled compounds. Data are also given on radionuclides that are potentially useful for brain tumor detection. (E.E.H.)

32474 INHALATION AND INTRAVENOUS METHODS FOR MEASUREMENT OF CEREBRAL BLOOD FLOW. Reinmuth, O. M. (Univ. of Miami, Fla.). pp 183-93 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The principles involved and the history of inhalation methods used for measuring cerebral blood flow are reviewed. The inhalation methods using ^{79}Kr and ^{85}Kr are described and their limitations noted. Another method using intravenous injection of ^{131}I-antipyrine was also evaluated. It was concluded that these methods have limited clinical use but are valuable for obtaining simultaneous information on the metabolic functions of the brain. (E.E.H.)

32475 INTRA-ARTERIAL METHODS FOR MEASUREMENT OF REGIONAL CEREBRAL BLOOD FLOW IN MAN. Lassen, Niels A. (Bispebjerg Hospital, Copenhagen). pp 194-202 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The use of radioactive tracers allows the measurement of the blood flow in various brain regions by using suitably placed external counters. Intravascular tracers follow the passage of the blood through the cerebral vessels. The tracers do not cross the blood-brain barrier. Examples of these are RISA or ^{99m}Tc-pertechnetate. The intra-arterial ^{133}Xe method uses a bolus injected into the internal carotid which freely crosses the blood-brain barrier. This method allows regional measurements within small regions of a single hemisphere. Two systems were developed for rapid data processing in clinical studies of regional cerebral blood flow by the intra-arterial ^{133}Xe method. Multiple small scintillation detectors are equipped with pulse height analyzers and the data are fed directly into a computer. A simpler system was devised in which 35 probes are fitted with individual ratemeters which play directly on the oscilloscope. (E.E.H.)

32476 TRANSIT TIME METHODS. Oldendorf, William H. (Wadsworth Veterans Administration Hospital, Los Angeles). pp 203-13 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

By noting the speed of passage of a γ emitting isotope through the brain compartments, clinically useful information about brain blood flow can be deduced. A method using intravenous injection of an ^{131}I-hippurate bolus was evolved to measure the brain blood compartment mode transit time or blood pool turnover time. It is assumed in this method that the isotope will remain in the blood compartment of the brain. Clinical use of this method showed that the transit time is prolonged in occlusive cerebralvascular diseases. It was concluded that this method could be a source of valuable information for the pathophysiology of brain infarctions. (E.E.H.)

32477 FACTORS INFLUENCING INFORMATION CONTENT OF BRAIN IMAGES. Mozley, James (Upstate Medical Center, Syracuse, N. Y.). pp 225-39 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The major factors influencing information content of brain images are described and illustrated. These are the administered dose, lesion uptake, photon energy of the radionuclide being used, the detector type, thickness of the detector, collimator design, pulse height analysis, electronic preprocessing, display and recording medium, postprocessing of the images, the visual perception of the observer, the conditions under which the final image is viewed, patient motion, the ratemeter time constant and scan speed parameter, and artifacts. (E.E.H.)

32478 INTERFERENCE OF SCALP AND SKULL WITH BRAIN ISOTOPIC MEASUREMENTS. Oldendorf, William H. (Wadsworth Veterans Administration Hospital, Los Angeles). pp 240-7 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

A method was developed to minimize the interference with brain scanning caused by extracranial soft tissue isotope content. The characteristic x rays of radioisotopes are used to correct for isotope emission originating outside the skull. Since there is a fixed ratio of γ rays to x rays produced by γ emitting isotopes both outside and inside the skull, the number of γ rays seen by the external detector which originate outside the skull can be predicted by subtracting the appropriate number of γ rays for each x ray detected. With this method, the characteristic x-ray scan can be subtracted from the γ scan which in turn would subtract the extracranial tissue interference, a major source of count in the routine brain scan. The characteristics of ^{99m}Tc, ^{125}I, ^{133}Xe, and ^{113m}In which are used in scalp subtraction are given. (E.E.H.)

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32479 HIGH RESOLUTION RECTILINEAR BRAIN SCANNING: IS IT WORTH THE EFFORT. Gottschalk, Alexander (Univ. of Chicago). pp 253-61 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The Argonne Cancer Research Hospital brain scanner is a single organ scanning device with two detectors on each side, which can scan two sides of the head simultaneously. The collimators were designed to sacrifice sensitivity and gain resolution. Brain scans from this scanner were interpreted and compared with results published by others who used conventional 3-inch scanning systems. The data indicated that this system with its higher resolution did not detect tumors more accurately than others had been able to achieve with either ^{99m}Tc-pertechnetate or ^{203}Hg-chlormerodrin. It does, however, help to characterize brain tumors better than other systems. (E.E.H.)

32480 VIDEOTAPE APPLICATIONS IN CEREBRAL BLOOD FLOW STUDIES. Ashburn, William L. (Univ. of California, San Diego. Univ. Hospital, San Diego, Calif.). pp 279-90 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The methods for obtaining serial images with the scintillation camera are discussed. Two methods employ a video tape recorder to store the raw data from which serial images can be reconstructed at essentially any frame rate and from which time-activity curves can be generated from anatomical areas of interest. The first method is the simplest and least expensive. It consists of focusing a standard vidicon TV camera on one of the two available oscilloscopes of the scintillation camera and recording the pattern on a video tape recorder. The second method consists of a video tape system interfaced with a Rho/Gamma 111 scintillation camera in such a way that the positioning signals which describe the random occurring scintillations are converted into eight binary bit digital pulses. The application of these methods in cerebral blood flow studies is illustrated. (E.E.H.)

32481 THREE DIMENSIONAL CEREBRAL BLOOD FLOW DETERMINATION BY MEANS OF EXCITED FLUORESCENT X-RADIATION. Ter-Pogossian, Michel M. (Washington Univ., St. Louis). pp 291-8 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

A method was developed for the in vivo determination of regional cerebral blood flow utilizing a nonradioactive indicator which is detected in the cerebral structures by exciting its fluorescent radiation with x rays. The technique and the equipment used are described. The advantages of the three dimensional cerebral blood flow determination are extraordinary regionality and the total amount of stable indicator can be accurately quantitated. The disadvantages of the system are the need for a large amount of stable indicator and the intensity of the exciting x ray beam must be high in order to obtain a flow curve. (E.E.H.)

32482 ^{99m}Tc-DIETHYLENETRIAMINEPENTAACETIC ACID AS A BRAIN SCANNING AGENT. Williams, Clyde M. (Univ. of Florida, Gainesville); Brookeman, Valerie A. pp 299-309 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Experiments were conducted to determine whether ^{99m}Tc-DTPA would prove to be superior to ^{99m}Tc-pertechnetate for clinical use as a brain scanning agent. Paired brain images were obtained with both scanning agents at least two days apart in 14 patients with a variety of intracranial lesions. Lesion-to brain and lesion-to-blood ratios were calculated. All lesions were visualized equally well with both scanning agents. Lesion-to-brain and lesion-to-blood ratios obtained at postinjection times from 10 min to three and one-half hrs. did not differ significantly. Because of the cost, ^{99m}Tc-DTPA cannot be advocated as a replacement for ^{99m}Tc-pertechnetate for brain scanning but it proved to be an excellent scanning agent for renal scanning or as a second brain scanning agent when a routine ^{99m}Tc-pertechnetate scan is equivocal or when choroid plexus activity obscures a possible lesion. (E.E.H.)

32483 RADIOISOTOPE CISTERNOGRAPHY, VENTRICULOGRAPHY AND MYELOGRAPHY. Di Chiro, Giovanni (National Institute of Health, Bethesda, Md.). pp 310-15 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Radioisotope cisternography, ventriculography, and myelography are techniques intended for studying clinically the production, circulation, and resorption of cerebrospinal fluid by scintigraphic methods. Cisternography is carried out by injecting either RIHSA or ^{99m}Tc-albumin into the lumbar region or occasionally by cisternal puncture. The lumbar and cisternal routes are also used for injection of ^{99m}Tc-albumin for myelography. For radioisotope ventriculography, ^{99m}Tc-pertechnetate is injected directly into the ventricular cavities. Cisternography is useful for diagnosis and localization of cerebrospinal fluid otorrhea and rhinorrhea. The most important application of cisternography and ventriculography is the study of communicating and noncommunicating hydrocephalus. (E.E.H.)

32484 USEFUL PATTERNS IN BRAIN SCAN DIAGNOSIS. Quinn III, James L. (Northwestern Univ., Chicago). pp 349-57 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

Clinical diagnosis of brain diseases using brain scanning with sodium pertechnetate has resulted in the emergence of some useful and significant patterns. Multiple areas of increased uptake is diagnosis of either multiple metastases or multiple abcesses. Patients with acute cerebral vascular accidents usually have an initially negative brain scan that becomes positive over a period of up to three weeks and then returns to normal. A noticeable characteristic of tumors is that they cross over from one vessel to another. It is unusual for them to undergo dramatic changes over a short period of time. The usefulness of delayed scanning is considered. The crescent pattern of increased uptake on the anterior and posterior views is characteristic of subdural hematomas. Radioisotope angiography is also discussed. (E.E.H.)

32485 EFFECTIVENESS OF BRAIN SCANNING FOR DETECTING INTRACRANIAL DISEASE. Goodrich, Jack K. (Duke Univ., Durham, N. C.); Wilkinson, Robert H. Jr. pp 365-74 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The diagnostic reliability of brain scanning was compared with that of other neurological tests or combinations of tests for clinical detection of various types of brain tumors, extracerebral tumors, inflammatory diseases, and cerebralvascular diseases. It was concluded that brain scanning with ^{99m}Tc pertechnetate is very effective for tumor detection but not as effective for the other conditions discussed and should be used in combination with other diagnostic techniques. (E.E.H.)

32486 NEUROLOGICAL CONSIDERATIONS IN THE UTILIZATION OF NEWER TECHNIQUES IN THE DIAGNOSIS AND MANAGEMENT OF BRAIN LESIONS. Bakay, Louis (Univ. of Buffalo). pp 375-86 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The various clinical procedures such as x-ray electroencephalography, echoencephalography, pneumoencephalography, and angiography used in combination with ^{99m}Tc brain scanning for diagnosis and management of brain lesions are discussed. The advantages, limitations, and indications for the use of each method are reviewed. (E.E.H.)

32487 DIFFERENTIAL DIAGNOSIS OF SPACE-OCCUPYING BRAIN LESIONS (NON-NEOPLASTIC). Gilson, Albert J. (Univ. of Miami, Fla.). pp 391-401 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

The detection of non-neoplastic space-occupying intracranial lesions using the Anger gamma camera and ^{99m}Tc is reviewed. The value of radioisotopic cerebral scans as an aid in the diagnosis and management of intracranial lesions is discussed. (E.E.H.)

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32488 BIOMEDICAL SCIENCES INSTRUMENTATION. VOLUME 6. Proceedings of the Seventh Annual Biomedical sSciences Instrumentation Symposium on Imagery in Medicine, Held May 19–22, 1969, in Ann Arbor, Michigan. Thomas, F. Deaver; Sellers, Ernest E. (eds.). Pittsburgh; Instrument Society of America (1969). 291p. (CONF-690520).

Separate abstracts were prepared on 15 papers presented at this symposium. Thirty-one additional papers discuss the economics in marketing biomedical engineering products, new developments in imagery for use in clinical diagnosis, holography, image processing, computer graphics, and medical television and other teaching aids. (C.H.)

For abstracts of individual papers see: 32235–32241 and 32489–32496.

32489 NEUTRON RADIOGRAPHY IN THE BIOMEDICAL FIELD: AN INTRODUCTION. Barton, John P. (Argonne National Lab., Ill.). Biomed. Sci. Instrum.; 6: 83-92(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Neutrons penetrate matter in a way comparable with x rays, and collimated beams of neutron radiation may be used to obtain information about the internal structure of objects. Because neutrons interact only with the nucleus of the atom, whereas x rays interact with the orbital electrons, neutron radiography can reveal information different from that revealed by normal roentgenography. Advances are being made in neutron sources, neutron collimators, and neutron-detection systems for neutron radiography, and, within the last two years various useful applications have been exploited in the field of industrial nondestructive testing. Within the biomedical field, some of the foreseeable advantages of neutron radiography are: the penetration through bone to study less dense matter; location of regions of high hydrogen content; and use of contrast agents different from those used for x rays. Technical factors that must be considered include; neutron energies; tissue penetration; scattering effects; and tissue dosage associated with neutron radiation beams. (auth)

32490 SELECTED BIOMEDICAL APPLICATIONS OF THERMAL NEUTRON RADIOGRAPHY. Allen, J. J.; Harmer, D. S. (Georgia Inst. of Tech., Atlanta). Biomed. Sci. Instrum.; 6: 93-7(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Current research in biomedical applications of thermal neutron radiography is discussed. The 1000 kilowatt Georgia Tech Research Reactor serves as the neutron source. Four phases of research in progress or to be shortly in progress are described. These include: establishment of a high resolution thermal neutron radiographic facility; preliminary toxicity studies on Chinese hamsters injected intraperitoneally with deuterated saline; determination of the reduced absorbed dose with deuteration; and evaluation of the radiographic system by means of modulation transfer functions determined from deuterated and non-deuterated materials in the beam. (auth)

32491 SLOW NEUTRON IMAGING OF FATTY TISSUES THROUGH DEUTERATION WITH HEAVY WATER. Brown, Mark (Medical Coll. of Georgia, Augusta); Allen, J. J.; Parks, P. B. Contract AT(07-2)-1. Biomed. Sci. Instrum.; 6: 98-103(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Slow neutron radiography of biological tissues has been extensively studied by several investigators. The findings of these studies show that: useful radiographs with low-to-moderate dose can only be taken of thin specimens (<one inch); bone cortex is radiolucent compared to muscle and fat; and fat and muscle cannot be easily distinguished. Modifications in these findings that follow from deuteration of biological tissues, in particular the improved delineation of fat, are reported. (C.H.)

32492 STEREOSCOPIC AND STOP ACTION NEUTRON RADIOGRAPHY OF BIOLOGICAL OBJECTS. Robinson, A. H.; Porter, C. R. (Oregon State Univ., Corvallis). Biomed. Sci. Instrum.; 6: 104-8(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

A number of techniques were developed to add one dimension (depth) and remove one dimension (time) from biological neutron radiography. In imaging of animate biological objects motion blurring during exposures (up to several minutes) can be a problem. Stop action imaging utilizes the reactor's pulsing capabilities which allow powers up to 1.2×10^3 watts to take neutron radiographs in 10^{-2} seconds. The contribution of the delayed neutron induced tail is discussed and methods for reducing this are demonstrated. Stereoscopic imaging is accomplished by taking successive pictures with angular displacement of the object occurring between exposures. This dimension greatly increases the information available from neutron radiography of complicated objects. Techniques for this and examples are described. (auth)

32493 MONTE CARLO SIMULATION OF BIOLOGICAL NEUTRON RADIOGRAPHY. Porter, C. R.; Robinson, A. H. (Oregon State Univ., Corvallis). Biomed. Sci. Instrum.; 6: 109-17(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

A computer program to investigate neutron beam behavior in a biological phantom using Monte Carlo techniques is presented. The phantom is homogenized animal tissue in disk geometry. Measurements were made with this material to determine the macroscopic total and differential scattering cross sections in the neutron beam spectrum. Using these data the program predicts post object neutron beam profiles at the image plane. The program considers a spherical inhomogeneity in the phantom containing a material of variable absorption and scattering cross sections from the rest of the phantom. Unscattered and total beam profiles are predicted at image planes at different distances from the phantom as a function of inhomogeneity cross section and various angular acceptances of both full and partial antiscatter grids. Optimum post object antiscatter grid design is discussed. The applicability of this approach to more complex biological systems is considered. (auth)

32494 PROBLEMS OF FAST NEUTRON RADIOGRAPHY. Parks, P. B. (E. I. du Pont de Nemours and Co., Aiken, S. C.); Brown, Mark; Harmer, D. S. Contract AT(07-2)-1. Biomed. Sci. Instrum.; 6: 118-26(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

Clinical applications of slow neutron radiography are severely restricted by the inability of slow neutrons to penetrate thick tissue specimens. Fast neutrons are capable of penetrating biological specimens as thick as human dimensions in sufficient numbers so that moderate-dose radiographs may be possible. The presently foreseen advantage of such a fast neutron technique would seem to be the ability to image air-filled structures in the presence of bone cortex without bone interference. To keep the fast neutron dose delivered to a live specimen within bounds and still maintain adequate statistics for imaging, the neutron detector must be highly efficient, which, in turn, means that the thickness of the detector must be large. However, thick detectors are difficult to use because of problems such as multiple scattering (and hence multiple detection) and poor geometry for transmission of detected-event information to the recorder. In addition, the most likely candidate for the detector, the organic scintillator, has a high sensitivity for gamma rays. Many of these physical problems can be minimized by the use of narrow beam geometries and appropriate gamma-ray discrimination techniques but with somewhat reduced resolving power. Narrow beam scanning approaches being developed are described. Particular emphasis is placed on the use of ^{252}Cf and accelerator neutron sources. (auth)

32495 THEORETICAL MODULATION TRANSFER FUNCTIONS AND DOSIMETRY FOR FAST-NEUTRON RADIOGRAPHY. Wilkie, W. H.; Harmer, Don S. (Georgia Inst. of Tech., Atlanta). Biomed. Sci. Instrum.; 6: 127-33(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

The image-forming quality of fast-neutron radiography systems is a function of several factors including the size and type of neutron source, the degree of collimation, the interaction of the neutrons with the object being examined, and the response characteristics of the detectors. The effects of these factors on imaging have not been demonstrated experimentally due to the inherent technical difficulties of this radiographic method. The detail-recording capability of radiographic systems may be determined by measuring the amount of amplitude distortion created by the various components and expressing these measurements as modulation transfer functions. Theoretical modulation transfer functions for tissue are presented. Monte Carlo techniques were used to analyze the theoretical neutron transport through tissue. Modulation transfer functions were calculated from the line-spread distributions predicted by the Monte Carlo analyses. The effects of tissue thickness and geometric unsharpness on imaging were examined for beams of 14-MeV neutrons and fission neutrons from californium-252. Since absorbed dose may be a limiting factor in the radiographic inspection of biological specimens in vivo, dosimetry calculations are presented. Both broad beam

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and narrow beam conditions were examined stochastically, and the results are shown as depth dose and isodose curves. (auth)

32496 INFLUENCE OF EXPOSURE PARAMETERS ON RADIOGRAPHS USED FOR DIAGNOSIS OF PATHOLOGICAL CHANGES WITHIN A SINGLE TISSUE. Webber, Richard L.; Ryge, Gunnar (Dental Health Center, San Francisco). Biomed. Sci. Instrum.; 6: 200-7(1969).

From seventh national biomedical sciences instrumentation symposium; Ann Arbor, Mich. (19 May 1969). See CONF-690520.

A double blind method for objectively evaluating the diagnostic results of dental radiography is reported. Radiographic densities were measured through the image of proximal dental enamel and expressed as a function of the log exposure for two representative radiation qualities. The slope of the resulting curves at density values 0.6 and 2.6 was found to be inversely related to the number of diagnostic errors resulting when a group of 12 dentists evaluated 16 randomly distributed bitewing pairs exposed under these conditions. The data suggest that 29% fewer diagnostic errors resulted when the density of proximal enamel was approximately four times greater than that judged to be properly exposed by the majority of the clinicians surveyed. Diagnostic quality was found to be relatively independent of kVp and primary beam filtration, suggesting that half-value layer is unreliable as an indicator of certain diagnostically significant characteristics of broad spectrum x radiation. The results are consistent with the concept that diagnostic information is maintained, while dose is minimized, when radiation is used which has a spectral band width only slightly larger than that range of energies just capable of penetrating the structures to be diagnosed. (auth)

32497 SELECTIVE ARTERIOGRAPHY OF THE INFERIOR MESENTERIC ARTERY. Bernardi, R.; Frasson, F.; Pistolesi, G. F. (Univ., Padua). Radiol. Med.; 66: 784-93(Sep 1970). (In Italian).

A procedure for selective catheterization of the inferior mesenteric artery for arteriography was developed. The technique was successful in 80% of the 70 patients studied. The diagnostic possibilities, based upon the demonstration of the relation between the inferior mesenteric artery and the adjacent vessels, are discussed. Examples are illustrated by angiographic pictures of various diseases of the intestines and rectum including malignant and benign tumors and ulcerative colitis. (E.E.H.)

32498 PLACENTAL LOCALIZATION: COMPARATIVE EVALUATION OF ISOTOPIC PLACENTOGRAPHY AND AMNIOGRAPHY. Drukker, Bruce H.; Reynolds, William A.; Ortiz, Eduardo; Josey, Julian C. (Henry Ford Hospital, Detroit). Amer. J. Obstet. Gynecol.; 110: No. 1, 9-14(1 May 1971).

Both RISA placentography and amniography were done for placental localization in an unselected series of 28 patients with third-trimester vaginal bleeding. Radiation to the fetus in isotopic placentography was considerably less than that required for placental localization by amniography. In addition, results indicated that isotopic placentography is more accurate, simpler, and avoids the potential hazards of amniocentesis. It is believed that isotopic placentography is preferable for placental localization and that amniography should be used only when isotopic placentography is not available. (auth)

32499 CLINICO-SCANNOGRAPHIC CHARACTERISTICS OF THE LIVER IN PATIENTS WITH CANCER OF THE LUNG AFTER COMBINED TREATMENT. Zubovskii, G. A.; Ryazanskaya, G. V.; Savitskaya, A. A. Med. Radiol.; 16: No. 3, 44-9(Mar 1971). (In Russian).

Clinical and scannographic data on the liver of 90 patients with lung cancer who underwent combined surgical treatment and radiotherapy were compared. The liver scans revealed changes caused by the character of the surgery and the presence of circulatory disturbances. In a number of cases, scanning permitted differentiation between congestive liver disturbances and metastases. This was not always possible on the basis of clinical and laboratory data. (auth)

32500 RADIATION DOSES TO PATIENTS DURING ROENTGENOCINEMATOGRAPHY. Sokolov, Yu. N.; Gasmaev, V. K.; Zolnikova, N. I.; Pavlova, T. G.; Glezin, F. Yu. (Central Inst. for Graduate Medical Studies, Moscow. Research Inst. of X Ray Radiology, Moscow). Vestn. Rentgenol. Radiol.; No. 1, 76-82 (Jan-Feb 1971). (In Russian).

The results of measurements on radiation doses to patients during different conditions of roentgenoscopy with the aid of an electron-optic amplifier, roentgenography and x ray cinematography of the stomach are given. A comparative assessment of total exposure doses and absorption of integral doses, calculated by the measurement results, was made. Superfluous doses in roentgenocinematography, 2 min cinematography with frequency of 12 exp/sec + roentgenoscopy with the aid of an electron optic amplifier, proved to be smaller than in conventional examination (6 min roentgenoscopy + series of 10 roentgenograms) — correspondingly 28 and 37 R. The same relation was revealed when integral absorbed doses were compared. It was concluded that the idea of increased radiation danger of gastric roentgenocinematography is not grounded. Such an opinion may arise only in the assessment of radiation doses which appear to be greatest during cinematography according to the data submitted. (auth)

32501 RADIOISOTOPE RENOGRAPHY IMPROVED BY SEQUENTIAL RENAL SCINTIPHOTOGRAPHY. Volpe, Joseph A.; Hardin, Virgil M.; Johnston, Gerald S. (Letterman General Hospital, San Francisco). Mil. Med.; 136: 479-83(May 1971).

The instrumentation and technique of combined radioisotope renography using ^{131}I-labeled hippuran and sequential renal scintiphotography are described. Illustrative cases indicate its superiority to conventional renography, in permitting a more accurate interpretation, and in eliminating several technical problems. It appears to be an excellent screening test, especially in the detection and evaluation of unilateral renal disease. (auth)

32502 EFFECT OF TECHNICAL AND METHODICAL IMPROVEMENTS ON PATIENT DOSE IN NUCLEAR MEDICINE. Pabst, H. W.; Kretschko, J. (Technische Univ., Munich). Radiologe; 10: 372-6(Sep 1970). (In German).

Radiation burden to the patient plays a decisive role in nuclear medicine. The development of equipment and techniques that significantly reduce patient dose are described. Discussion is also presented on: collimator detector systems of high sensitivity for scintigraphy; electronic data evaluation for improved statistical analysis of results; 4 π whole-body counters with liquid or plastic scintillators; special methods with semi-conductor detectors; and activation analysis. These methods in combination with short-lived radionuclides result in such low radiation burdens that examinations present no risk to the patient. (tr-auth)

32503 STUDIES ON AFFINITY OF THE ELEMENT IN GROUP III IN THE PERIODIC TABLE FOR MALIGNANT TUMORS. Ando, Atsushi; Hisada, Kin-ichi (Kanazawa Univ., Japan). Radioisotopes (Tokyo); 20: 171-9(Apr 1971). (In Japanese).

Studies were made on the affinity of ^{113m}In, ^{114m}In, ^{67}Ga, and ^{46}Sc for malignant tumors in rats with subcutaneously transplanted Yoshida sarcoma. The results indicated that several different compounds of ^{113m}In, ^{114m}In and ^{67}Ga had a strong affinity for malignant tumors but ^{46}Sc compounds did not. The compounds that showed a strong affinity for malignant tumors were those in a carrier-free state. Gallium compounds containing a small amount of carrier still had a strong affinity for tumors, but even with a small amount of carrier, indium compounds did not. Gallium compounds and indium compounds suitable for the selective uptake by tumors showed a very strong affinity for the tumors and their retention values were approximately the same, but the retention values in the blood and kidneys were larger with In than with Ga. The results indicated that Ga is more suitable for tumor detections than In. (E.E.H.)

32504 METHOD OF RADIOISOTOPE SCINTIPHOTOGRAPHY IN THE DIAGNOSIS OF BRAIN DISEASES. Nosikova, S. M.; Petelin, L. S.; Kasatkin, Yu. N. Zh. Nevropatol. Psikhiat.; 70: 1605-12(1970). (In Russian).

Using radioisotope scintiphotography RISA, 55 patients with brain tumors, and vascular and inflammatory brain processes were studied. Thirty of these cases were verified. Tumors, abscesses, and hemorrhages displayed distinct foci of increased radioactive accumulation. The degree of isotope accumulation depended upon the localization, histological structure, and dimensions of the tumor. In a supratentorial localization, the depth of the neoplasm changed the results insignificantly. A less distinct picture was attained in tumors of the posterior brain cavity, of the hypophysis, and structures of the sellar area. The scintophotographical pictures in hemorrhagical strokes depended upon the localization, dimensions, and stages of the disease. In inflammatory processes, typical foci of isotope accumulation were seen only in abscesses. These data indicated the interdependence of the character of isotope accumulation and the nature of the disease. (auth)

Radiotherapy

Refer also to abstracts 32426, 32427, 32429, 32515, 32554, 32562, 32594–32604, 32606–32609, 32612, and 32626.

32505 CLINICAL AND THEORETICAL MODELS IN RADIOTHERAPY. Spring, Erik; Paasikallio, Kirsti (University Central Hospital, Helsinki). Strahlentherapie; 140: 508-14(Nov 1970).

An examination was made of the clinical results of the variation in total dose during fractionated therapy, published by Fowler (1965) and Cohen (1968), by application of the single-hit, multi-target model. As a realistic model for calculations of fractionated radiotherapy, the following formula $S = \{1-(1-e^{-D/300})^{1.5}\}^{N} e^{0.1T} - 0.01\ e^{-N}$ is proposed where D is the dose per fraction, N the number of fractions, and T the total treatment time in days. For the growth constant L (1/days), a value of 0.10± 0.03 was obtained. (auth)

32506 POSTOPERATIVE ^{60}Co TELETHERAPY OF MAMMARY CARCINOMAS. RESULTS ON 265 PATIENTS. Heinze, H. G.; Feil, E. (Univ., Munich). Strahlentherapie; 140: 468-77(Nov 1970). (In German).

Postoperative ^{60}Co-teletherapy in 265 patients suffering from mammary carcinoma, 90% of whom were treated surgically according to Rotter-Halsted is reported. Stage classification was carried out as recommended by UICC. The five-year survival rates and the so-called five-year healing rates are given. During an observation period of six years, in stage I, the same average survival rate was reached as in the case of healthy women of the same age. In progressive stages, the healing rate decreased progressively. Local recidivations were manifest only in 4.7% of the cases. This was regarded as a success of ^{60}Co teletherapy radiation. The histology, the age, and duration of the symptoms are discussed as well as the radiation sequelae. (auth)

32507 EXPERIENCE WITH COMBINED (ALTERNATING) RADIATION USING FAST ELECTRONS AND ULTRA-HARD X RAYS. Vieten, H.; Guenther, D. (Univ., Duesseldorf). Strahlentherapie; 140: 349-53(Oct 1970). (In German).

A combined irradiation, alternating every day by fast electrons and ultra-hard x rays of maximum energies of 15 to 18 MeV, was found to be especially appropriate for half-depth therapy (about 1 to 5 cm); this irradiation method permits the application of radiation quantities of 7000 to 8000 R on tumefactions localized there, without any excessive reactions on the surface and in the depth. This irradiation, furthermore, appears to be advantageous for depth therapy as well, in case stronger energies (40 MeV) are applied. (auth)

32508 INOPERABLE ESOPHAGUS CARCINOMA: RESULTS OF CONVENTIONAL DEEP X RAYS AND TELEGAMMA THERAPY. Becker, G.; Fassbender, C. W. (State Hospital, Dortmund, Ger.). Strahlentherapie; 140: 354-61(Oct 1970). (In German).

A review of 56 cases of inoperable oesophagus carcinoma, treated at the Radiological Clinic of Dortmund is presented. The results were examined as a function of the tumor extent, its localization, and the duration of symptoms, and compared with results published in the literature. In 42 patients, a curative tumor-dose of 6000 rad was given. The superiority of telegamma therapy was found by calculation of the mean survival and by the one-year survival after curative or palliative treatment. The mean survival after gamma therapy was 14.2 months, and after conventional irradiation only 7.3 months. The rather poor results obtained by radiotherapy and by surgery with its still high mortality will perhaps be better after a combination of both methods of treatment. (auth)

32509 PERCENT HEALING EXPECTATION OF CERVICAL CARCINOMA IN RELATION TO STADE DISTRIBUTION AND AGE OF THE PATIENT. Grossmann, H. (Karl Marx District Hospital, Karl-Marx-Stadt, Ger.). Strahlentherapie; 140: 362-5(Oct 1970). (In German).

Increasing successes in carcinoma colli uteri-therapy have rendered more and more important the significance of composition of age and stages in the patients treated, i.e., besides the manner in which treatment is carried out. By introducing the percent expectation of a five-year-treatment the effects of both items within a collective can be represented by one single number. On using this percent expectation of healing factors, a comparison of effect between patients only irradiated and those who had undergone an operation was not possible, as on selecting the irradiated patients further factors become efficient, which cannot be taken into consideration as to their value. (auth)

32510 FOCUSING TECHNIQUES DURING COBALT THERAPY OF KIDNEY TUMORS. Roedel, Kurt; Ringleb, Dietrich (Univ., Giessen, Ger.). Strahlentherapie; 140: 366-73(Oct 1970). (In German).

The target-volume for preoperative or postoperative irradiation of renal tumors includes the renal loge and the paraaortic lymph nodes. The parameters of the irradiation technique with static fields or moving beam techniques were modified in order to obtain an optimal dose distribution with appropriate isodose forms. For preoperative irradiation, preference was given to static fields with three beams, some of which use wedge filters and sieves. Biaxial pendular rotation is recommended for postoperative irradiation. These problems were more easily solved with electron beams. (auth)

32511 RADIOTHERAPY OF RECURRENT MALIGNANT NEOPLASMS OF THE UTERUS WITH 42 MeV BETATRON. Maestro, A.; Casolo, F.; Slaviero, E.; Garbagna, P. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 293-303(Nov 1968). (In Italian).

The procedure for using photon beams from a 42 MeV betatron in the radiotherapy of 33 patients affected with recurrent carcinomas of the cervix is reported. The advantages in using photon radiation at very high energies are described. The types of reactions (early and delayed) observed and the immediate results obtained in these patients are reported. Of the 33 patients treated, 12 still survive without signs of neoplasia for more than two years after the radiotherapy. (tr-auth)

32512 THERAPY OF VAGINAL CARCINOMAS. Vahrson, Helmut (Univ., Giessen, Ger.). Strahlentherapie; 140: 492-8(Nov 1970). (In German).

Intensive planning for the radiotherapy of vaginal carcinoma at the gynecology clinic of Göttingen and GieBen has almost doubled the cure results by reducing the radium dose associated with conventional x rays. In order to obtain better results, telecobalt therapy using the biaxial pendular technique has been associated with 2000 mg/hours radium in two applications. The tumor dose given by external irradiation is 5000 R. Initial results have been encouraging. (auth)

32513 VALUE OF PREOPERATIVE OR POSTOPERATIVE TREATMENT BY RADIUM FOR CARCINOMA OF THE UTERINE BODY. Graham, John (State Univ. of New York, Buffalo). Surg. Gynecol. Obstet.; 132: 855-60(May 1971).

Preoperative or postoperative use of radium therapy has been advocated to improve the results of total hysterectomy for uterine carcinomas. A study was conducted on 123 patients with stage I, group I tumors in whom supplemental treatments were randomly assigned. The 5 yr. cure rate with hysterectomy alone was 64% or 21 of 33 patients, the vaginal recurrence rate was 12%, and the death rate from carcinoma was 12%. Of the patients treated preoperatively with radium, the 5 yr. cure rate was 76% or 45 of 59 patients, the vaginal recurrence rate was 3%, and the death rate from carcinoma was 14%. Of those receiving radium postoperatively, the 5 yr. cure rate was 81% or 25 of 31 patients, there were no recurrent vaginal tumors, and 3% died from carcinoma. (E.E.H.)

32514 CURRENT THERAPEUTIC POSSIBILITIES IN IDIOPATHIC MYELOFIBROSIS. OBSERVATIONS ON 47 CASES. Perugini, Sergio; Ascari, Edoardo; Fontana, Giuseppe (Univ., Modena, Italy). Clin. Ter.; 45: 21-60(15 Apr 1968). (In Italian).

The etiology and pathology of myelofibrosis are reviewed and various therapeutic measures are evaluated. Results are reported for seven cases treated with 600 to 1000 rad doses of x radiation delivered to the spleen. The use of ^{51}Cr- and ^{59}Fe-labeled erythrocytes for the therapy of blood disorders associated with myelofibrosis is also discussed. It is pointed out that both irradiation and the administration of radioisotopes must be carried out with great caution in patients with myelofibrosis. (C.H.)

Radiation Effects on Animals

Refer also to abstracts 32355, 32438, and 32439.

32515 (LA-4653) PROGNOSTIC VALUE OF CELLULAR STUDIES IN EVALUATING NEW ACCELERATOR BEAMS FOR THERAPY. Todd, Paul (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 16p. Dep. NTIS.

Quantitative cell biology has provided techniques for estimating cell survival following exposure to ionizing radiations with varying linear energy transfer (LET) under conditions of anoxia and oxygenation. Anoxic cells are approximately three times more resistant to low LET radiations than cells exposed in the presence of oxygen. Doses required to effectively sterilize a tumor are generally higher than the normal surrounding tissues can tolerate. Therefore, the central problem in radiotherapy is to develop techniques that selectively deposit adequate killing doses in the tumor volume while inflicting minimum damage to inter-

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vening and surrounding normal tissues. A possible solution to this problem may be provided by the new generation of particle accelerators, which produce heavy ions, negative pions, and neutrons. These particles offer a solution also to the problem of regulated energy deposition and permit effective cell killing within definable tissue volumes because of favorable LET considerations in the plateau and terminal regions of the Bragg peak. Other advantages, which make negative pions particularly attractive, are the relative independence from oxygen effects and a higher relative biological effectiveness (RBE) in the tumor volume, with less recovery between doses than is presently the case with conventional techniques. Tumor sterilization can be effected with less dose to skin and intervening tissues than now experienced with conventional split-dose multiple port techniques. (auth)

Invertebrates

Refer also to abstracts 32369, 32382, 32383, 32387, and 32635.

32516 MATING BEHAVIOUR OF GAMMA-IRRADIATED AND NON-IRRADIATED EUROPEAN CORN BORER, OSTRINIA NUBILALIS (HUBNER). Anwar, M.; Feron, M. (Centre de Recherches Agronomiques du Sud-Est, Montfavet, France). Int. J. Appl. Radiat. Isotop.; 22: 89-93(Feb 1971).

Mating studies of the European corn borer, Ostrinia nubilalis (Hübner) were conducted in the laboratory. These studies indicate that mating occurred within 2 days of emergence and always at night. The moths mate between 11:45 p.m. and 5 a.m. with a maximum between 1 a.m. and 3 a.m. The duration of copulation ranged from 75 to 135 min. It was found that each spermatophore present in the bursa copulatrix of a mated female represented one mating. Observations showed that the male is capable of mating more than once. When 5 males were placed with 30 females, the average number of spermatophores produced was 2.2 per male; when 30 males were caged with 5 females, the average number of spermatophores produced per male was 0.4. Cages containing equal number of males to females produced, on an average, 1.4 spermatophores per male. There appears to be some stimulus produced by the unmated female which induces the male to seek out virgin females. The mating ability of males sterilized as pupae was found to be fully competitive with untreated males and the irradiated females mated as frequently as the control. (auth) (UK)

32517 DOSE-FRACTIONATION AND THE STERILIZATION OF RADIOSENSITIVE MALE CONFUSED FLOUR BEETLES. Ducoff, H. S.; Vaughan, Alice P.; Crossland, Janice L. (Univ. of Illinois, Urbana). J. Econ. Entomol.; 64: 541-3(Apr 1971).

The McGill Black strain of the flour beetle, Tribolium confusum, was used to evaluate some of the factors that influence lethality and the kinetics of repair after irradiation. Adult males were x irradiated between 3 and 14 days after eclosion with doses of 4 to 8 kR in various fractionation patterns and mated 1 day, 1 week, or 6 weeks later. A considerable degree of repair of lethal damage during intervals between dose fractionation occurred in a matter of hours, but there was no indication of any increase in fertility. Complete sterility was produced in males exposed to 900 R in 10 equal fractions of 2 fractions daily for 5 consecutive days. This sterility persisted for more than 7 weeks. The results demonstrated that even relatively radiosensitive beetles can be sterilized with a good survival rate by suitably chosen fractionation patterns. The rapidity of repair suggests a process similar to the repair of sublethal cellular damage observed in cultured mammalian cells. (E.E.H.)

32518 STABILIZING EFFECTS OF D_2O ON THE MICROTUBULAR COMPONENTS AND NEEDLE-LIKE FORM OF HELIOZOAN AXOPODS: A PRESSURE–TEMPERATURE ANALYSIS. Marsland, Douglas; Tilney, Lewis G.; Hirshfield, Michael (Marine Biological Lab., Woods Hole, Mass.). J. Cell. Physiol.; 77: 187-93(Apr 1971).

A systematic study of the resistance of heliozoan axopodia to pressure-induced disintegrational changes has shown that progressively higher concentrations of D_2O in the environing medium produce a progressively greater stability, not only as to the needle-like form of the whole axopodia, but also as to their microtubular components. Also it was found that a higher temperature (25°C) yielded significantly higher stability values with identical degrees of deuteration, as compared with experiments performed at a lower temperature (20°C). (auth)

32519 TRITIATED THYMIDINE FIXATION IN SEROGENOUS GLAND DNA IN BOMBYX MORI UNDER THE INFLUENCE OF gamma AND UV RADIATION. Floca, Liviu; Pora, Eugen A. (Centrul de Cercetari Biologice, Cluj). Stud. Cercet. Biol., Ser. Zool.; 22: 345-51(1970). (In Rumanian).

Results concerning the level of the total mark of the gland, compared to the level of the precursor metabolized in the gland DNA, point out marked differences in the metabolic activity of the gland sections and larval stages. The influence of uv and γ rays became evident in the 4th larval stage as an inhibition of the phosphorylation and thymidine incorporation process was noted together with the increase of the uv dose and the modification of the membrane permeability process of the gland cells. The lowest γ radiation dose enhanced the phosphorylation process of the radioactive precursor, the energy of these radiations being thus utilized in the biosynthetic process in cells. (auth)

32520 MORPHOLOGICAL CHANGES IN CELLULAR ORGANELLES OF X-IRRADIATED BACTERIA-FREE GRASSHOPPER DIAPAUSE EMBRYOS. Tahmisian, Theodore N.; Wright, Betty Jean (Argonne National Lab., Ill.). Radiat. Res.; 46: 165-85 (Apr 1971).

The grasshopper (Melanoplus differentialis) embryo during diapause was used to study the effects of x irradiation on the ultrastructure of cells in a basal metabolic condition. The gross effect of 25 kR on the embryo was diminution in size. Ultrastructurally, the cells exhibited injury earlier than could be detected by gross morphology. The nucleolus showed radiation injury first and ultimately the whole nucleus became pyknotic. The cytoplasm of irradiated cells contained an abundance of rough endoplasmic reticulum, an organelle rarely found in the control cells. There was also an increase in free ribosomes in the treated cells. Cytoplasmic myelination and the presence of cytolysomes was common in the x-irradiated cells. The mitochondria, for the most part, remained undamaged although their overall shape was modified and a few did become myelinated. The centriole remained unchanged throughout the entire postirradiation period. Organelles were differentially susceptible to irradiation; some exhibited no change, some were duplicated, some underwent degradation, and at times structures never seen in normal cells were newly synthesized. (auth)

32521 SUPRALETHALLY X-IRRADIATED AMOEBAE TREATED WITH NONIRRADIATED, HOMOGENIZED PROTOPLASM. Daniels, Edward W.; Breyer, Evelyn P. (Argonne National Lab., Ill.). Radiat. Res.; 46: 85-8(Apr 1971).

Amoebae (Pelomyxa illinoisensis) die without mitosis or cell division within a week after exposure to 30 kR x radiation. X-irradiated amoebae injected with nonirradiated protoplasm removed from donors by a micropipette, or with homogenates made from nonirradiated amoebae, divided and produced cultures similar to those of the nonirradiated controls. The radiorestorative capacity of nonirradiated protoplasm thus can be maintained in a pipette in the absence of a foreign medium outside of the cell, or in a homogenate properly made in a relatively nontoxic medium, for a period long enough to introduce it into an irradiated cell. Cell membranes (plasmalemmas) of the donor amoebae were not required for radiorestoration. (auth)

32522 AGE CORRELATED SENSITIVITY TO ULTRAVIOLET RADIATION IN PARAMECIUM. Smith-Sonneborn, Joan (Univ. of Wisconsin, Madison). Radiat. Res.; 46: 64-9(Apr 1971).

Clonal age is a significant variable in the percent survival of Paramecium exposed to different doses of ultraviolet irradiation. Within given age limits the uv damage is reversible by photoreactivation. The data are consistent with the hypothesis that aging in Paramecium is correlated with the inability of the cells to repair genetic damage. (auth)

32523 PROMPT DETECTION OF IONIZING RADIATIONS BY A MARINE COELENTERATE. Kimeldorf, Donald J.; Fortner, Rosanne W. (Oregon State Univ., Corvallis). Radiat. Res.; 46: 52-63(Apr 1971).

The sea anemone, Anthopleura xanthogrammica, was the subject of a study regarding the detection of ionizing radiations by an organism with a relatively elementary nervous system. The results indicated that the anemone can detect x rays and will withdraw its tentacles with an exposure of 20 R or more. Reaction time varied inversely with exposure rate, ranging from 102 seconds at 20 R/sec to 266 seconds at 1 R/sec. Reaction time was not affected by exposure duration at a given exposure rate once a threshold amount had been exceeded. Tentacle withdrawal was followed at higher exposures by a sequence of oral disc and column reactions leading to complete closure of the oral disc. Both local reactions and reactions outside the field of exposure could be demonstrated. On the basis of related experiments and the present results, it appears likely that ionizing radiations may activate an unknown photoreceptor mechanism and/or act directly on the neuromuscular pro-

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cesses to initiate the behavioral response. It was apparent that a highly specialized neural system is not essential for the detection of ionizing radiations. (auth)

32524 MICROSPECTROPHOTOMETRIC STUDIES OF THE EFFECT OF ^{60}Co IRRADIATION ON DNA SYNTHESIS IN GERM CELLS OF THE FACE FLY. Tung, Pierre Sik-chung; Mitchell, Robert B.; Anthony, Adam (Pennsylvania State Univ., University Park). J. Insect Physiol.; 17: No. 2, 277-84(1971).

Cytological and histochemical analyses of spermatogenesis in the face fly, Musca autumnalis DeGeer, were conducted following γ irradiation of pharate adults 96 hr after the onset of puparium formation. Three dose levels (600, 2000, and 4000 rad) were employed and gonads analyzed at four time intervals (1, 2, 5, and 10 days) post-irradiation using phase contrast microscopy, light microscopy after aceto-orcein staining, and cytophotometry following Feulgen staining. The 2000 and 4000 rad doses resulted in a progressive decrease in the number of secondary spermatogonia and primary spermatocytes undergoing premitotic or premeiotic DNA synthesis, a decrease in the overall number of primary spermatocytes in the testes, and a near absence of dividing cells. Following the 600 rad treatment, there was a slight increase in the number of cells exhibiting elevated Feulgen-DNA levels (i.e undergoing DNA synthesis) 2 days post-irradiation, an increase in the number of primary spermatocytes 2 and 3 days post-irradiation, and an initial 1-day decrease in the number of dividing nuclei followed by a 2- to 3-day mitotic increase over control levels. The combined data indicated that at the higher dose levels (2000 to 4000 rad) there is an inhibition of DNA synthesis resulting in an interruption of the spermatogenic process. After the 600 rad exposure, there was no observable decrease in DNA synthesis, but there was an apparent retardation in the rate of spermatogenesis. The results support the concept that differential radiosensitivity of germ cells is influenced, in part, by differences in radioinduced inhibition of DNA synthesis. (auth)

32525 RADIORESISTANCE OF NERVES IN AMPHIBIAN LIMB REGENERATION. Wallace, H. (Univ. of Birmingham, Eng.); Wessels, S.; Conn, H. Arch. Entwicklungsmech. Organ.; 166: 219-25(1971).

The limbs of salamanders can regenerate even if their nerves are x irradiated, provided that some other non-irradiated tissue reaches the site of amputation. This conclusion was reached by repetition of an earlier experiment, which yielded contradictory results. The experimental design did not demonstrate any radiosensitivity of nerves, but indicated that very few non-irradiated cells suffice to initiate regeneration. On the basis of this conclusion and other unconfirmed experiments, the possibility is considered that x-irradiated cells can recover their ability to regenerate. (auth)

Vertebrates

Refer also to abstracts 32322, 32332, 32344, 32346, 32352, 32364–32366, 32368, 32379, 32443, 32444, 32446, 32447, 32455, 32457, 32461, and 32463.

32526 (CONF-700501) MORPHOLOGY OF EXPERIMENTAL RESPIRATORY CARCINOGENESIS. Proceedings of a Conference held in Gatlinburg, Tennessee, May 13–16, 1970. AEC Symposium Series 21. Nettesheim, P.; Hanna, M. G. Jr.; Deatherage, J. W. Jr. (eds.) (Oak Ridge National Lab., Tenn.). Dec 1970. 498p. Dep. NTIS.

Twenty-seven papers are included; separate abstracts were prepared for four. The remaining 23 papers contain information on: the structure and function of cellular elements in the lungs and their response to injury; human lung tumors, classification of lung tumors in domestic and experimental animals; and current experiments in respiratory carcinogenesis. (E.E.H.)

For abstracts of individual papers see: 32527–32530.

32527 (CONF-700501–, pp 147-60) THE MORPHOLOGY OF EXPERIMENTAL LUNG TUMORS IN BEAGLE DOGS. Howard, Edwin B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Conference on morphology of experimental respiratory carcinogenesis; Gatlinburg, Tenn. (13 May 1970).

In Morphology of experimental respiratory carcinogenesis.

The results of a long-term study to evaluate the pathologic effects in the lungs following $^{239}PuO_2$ particle inhalation using beagle dogs as the experimental animals are described. Of 40 dogs exposed to $^{239}PuO_2$ particles having a count median diameter of 0.1 to 0.5 μ, 22 died with primary lung neoplasia 38 to 110 months post exposure, eight died of pulmonary fibrosis, five were killed for radionuclide distribution measurements, and five are still alive nine years post exposure. Initial alveolar deposition ranged from 0.5 to 3.5 μCi, and accumulated radiation dose was 2500 to 12,000 rads. Most lung tumors were found to be bronchiolo-alveolar carcinomas of peripheral origin, with two peripheral squamous cell carcinomas and three epidermoid carcinomas. There were also three dogs with thoracic sarcomas and two dogs with malignant lymphomas. (auth)

32528 (CONF-700501–, pp 383-94) RESPIRATORY CARCINOGENESIS IN HAMSTERS INDUCED BY ^{210}Po ALPHA RADIATION AND BENZO[a]PYRENE. Little, John B.; Grossman, Barbara N.; O'Toole, William F. (Harvard School of Public Health, Boston, Mass. New England Deaconess Hospital, Boston, Mass. Harvard Medical School, Boston, Mass.).

From Conference on morphology of experimental respiratory carcinogenesis; Gatlinburg, Tenn. (13 May 1970).

In Morphology of experimental respiratory carcinogenesis.

High yields of respiratory cancers have been induced in hamsters exposed to multiple intratracheal injections of either ^{210}Po or benzo[a]pyrene adsorbed onto hematite particles. With injected ^{210}Po radioactivity estimated to deliver 4500 rads to the whole lungs over the lifetime of the animals, bronchogenic carcinomas occurred in 91% of exposed hamsters with induction times as short as 15 weeks after the beginning of treatment. The radioinduced tumors were all characteristic mixed epidermoid and adenocarcinomas which arose peripherally and were frequently multicentric in origin. The benzo[a]pyrene-induced tumors, on the other hand, were primarily epidermoid carcinomas of the trachea and large bronchi. (auth)

32529 (CONF-700501–, pp 395-415) TOXICITY OF BETA-EMITTING RADIONUCLIDES INHALED IN FUSED CLAY PARTICLES: AN EXPERIMENTAL APPROACH. McClellan, R. O.; Barnes, J. E.; Boecker, B. B.; Chiffelle, T. L.; Hobbs, C. H.; Jones, R. K.; Mauderly, J. L.; Pickrell, J. A.; Redman, H. C. (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex. Fission Product Inhalation Labs.).

From Conference on morphology of experimental respiratory carcinogenesis; Gatlinburg, Tenn. (13 May 1970).

In Morphology of experimental respiratory carcinogenesis.

An experimental approach to evaluation of the toxicity of inhaled beta-emitting radionuclides using the beagle dog is described. This approach emphasizes evaluation of the influence of radiation dose rate and total radiation dose on the dose-response relationship for inhaled beta emitters. This was accomplished by studying groups of dogs exposed to aerosols of fused clay containing ^{90}Y, ^{91}Y, ^{144}Ce, or ^{90}Sr to achieve graded initial lung burdens that, because of differences in physical half-life, result in irradiation of the lung with dose rates that decrease with effective half-times of 2.5, 50, 150, or 300 days, respectively. The initial lung burdens used were selected to result in early deaths due to marked tissue alterations at the highest levels, deaths at later times due to moderate to marked pathologic changes including fibrosis and possibly neoplasia at intermediate levels, and more subtle changes including neoplasia at the lower levels. Over the midrange of the relationship between radiation dose and biological response, it will be possible to compare the relationships for the several radioactive aerosols with their different radiation dose patterns. (auth)

32530 (CONF-700501–, pp 417-36) COCARCINOGENIC STUDIES IN PULMONARY CARCINOGENESIS. Park, J. F.; Howard, E. B.; Stuart, B. O.; Wehner, A. P.; Dilley, J. V. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From Conference on morphology of experimental respiratory carcinogenesis; Gatlinburg, Tenn. (13 May 1970).

In Morphology of experimental respiratory carcinogenesis.

Cocarcinogenic experiments are currently in progress to determine the pathogenesis of several potentially carcinogenic materials on the induction of pulmonary neoplasia in experimental animals. The role of plutonium-induced lymphopenia and lymphatic pathology is being evaluated in the pathogenesis of pulmonary neoplasia induced by inhalation of $^{239}PuO_2$ in beagle dogs. Hamsters and dogs are being exposed to combinations of uranium mine air contaminants including radon daughters, uranium ore dust, diesel engine exhaust, and cigarette smoke. The cocarcinogenicity of inhaled asbestos, nickel oxide, cobalt oxide, and cigarette smoke is being investigated in hamsters. (auth)

32531 REGULATION OF LIPID METABOLISM IN LIVERS OF IRRADIATED MICE. Berndt, Juergen (Univ., Freiburg i. B.). Strahlentherapie; 140: 577-93(Nov 1970). (In German).

XUM

The influence of a whole-body x irradiation on the enzymes participating in the fatty acid and cholesterol biosynthesis was investigated in mouse liver. The contents of the end products of these two synthetic routes (fatty acid CoA derivatives and cholesterol) were measured. It was demonstrated that radio-induced changes in fatty acid and cholesterol synthesis are due to changes in the activity of the rate limiting enzymes. The regulation of these processes by end product inhibition (feed-back) was disturbed after irradiation. (auth)

32532 COMBINED EFFECT OF IRRADIATION AND OF SOME HORMONES ON CATHEPTIC ACTIVITY IN RAT SPLEEN. Babnik, J.; Lebez, D. (Jozef Stefan Inst., Ljubljana, Yugoslavia). Strahlentherapie; 140: 557-60(Nov 1970).

Spleen catheptic activity was followed after ^{60}Co γ irradiation in rats pretreated with the following hormones: insulin, epinephrine, hydrocortisone, and ACTH. Hormones were injected i.p. into animals 15 min before irradiation with 640 R. The results showed considerable change in catheptic activity in animals pretreated with hormones. Insulin and hydrocortisone caused an increase in catheptic activity 30 min after irradiation, whereas epinephrine and ACTH had the opposite effect. Three hours after irradiation, catheptic activity decreased toward the control value in insulin and hydrocortisone pretreated animals. ACTH and epinephrine caused an increase in activity until the third hour after irradiation. (auth)

32533 EFFECTS OF X RADIATION DURING BLASTOGENESIS, ORGANOGENESIS, AND FETAL PERIOD ON EARLY POSTNATAL DEVELOPMENT OF MICE. Konermann, Gerhard; Helberg, Marlies; Kraft, Angelika (Univ., Freiburg i. B.). Strahlentherapie; 140: 561-72(Nov 1970). (In German).

During the main phases of the prenatal development as blastogenesis, organogenesis, and fetogenesis, pregnant mice were subjected to daily fractionated x irradiation with 40, 60, and 80 R/d in order to study postnatal survival and growth of the offspring during the first 3 weeks of postnatal life. Irradiation at 80 R/d produced only small effects on survival when applied during fetogenesis (days 14 to 18 p.c.), but caused a slight deficit in the average weights. However, irradiation during organogenesis (days 6 to 13 p.c.) amounting to 40 R/d, resulted in an increase in neonatal deaths and in an extreme weight retardation. Irradiation during blastogenesis (days 1 to 5 p.c.) caused a high incidence of prenatal deaths, but were without or with little initial (80 R/d) influence on the survival of the reduced number of offspring that came to term. This offspring even showed a significant postnatal overgrowth. The differences in the sequelae of the prenatal irradiations before and after birth are discussed with special regard to recovery and selection depending on the stage of development that was treated. (auth)

32534 CHANGES IN NATURAL RADIORESISTANCE IN MICE DURING SEVERAL DAYS IN HYPOXIC SURROUNDINGS: ORGAN WEIGHTS OF NORMAL AND RADIORESISTANT ANIMALS FOLLOWING IRRADIATION. Tribukait, Bernhard (Karolinska Institutet, Stockholm). Strahlentherapie; 140: 540-52(Nov 1970). (In German).

The following items were examined after irradiation with 900 R ^{60}Co: fresh weight, dry weight, water content, and—in some cases—fat content of the organs and body parts of normal mice and mice in which the radiosensitivity was decreased after ten days pre-treatment in hypoxia. The body weight of normal irradiated mice changes in a two-phase effect reaching a minimum on the fourth day, a plateau until the eighth day, and decreasing again strongly until exitus after about a fortnight. All organs contributed to these alterations. The muscles, subcutaneous tissues, and contents of the stomach and intestines contributed the greatest part of the change in body weight. The spleen lost 75% of its original weight, the thymus 50%, liver and kidneys both 30%, and heart and lungs 10 to 15%. The water content of the tissues rose continuously. The body weight of animals irradiated 48 hr after hypoxia decreased initially, corresponding to that of the control animals. The secondary decrease, however, did not take place. Thirty days after irradiation, the body weight was significantly below that of the controls pre-treated in hypoxia. All organs participated in this weight reduction and the weights of the organs, expressed as percentages of the whole-body weight, remained normal. The variations in all the organ weights indicated the generality of the irradiation effect. (auth)

32535 PERMEABILITY OF THE SKIN FOR NOBLE GASES. Ojeda, Flavio (Univ., Giessen, Ger.). Strahlentherapie; 140: 605-9(Nov 1970). (In German).

The skin permeability for radon-222 was studied in the tails of rats before and after uv and x irradiation. The erythema produced was also measured. The amount of radon penetrating the skin was determined by measuring the gas exhalation radiometrically. In order to estimate the influence of radon accumulation in the body, radon exhalation was investigated after ligaturing the tail. From the very rapid decrease of radioactivity in the exhaled air it was concluded that the exhalation kinetics of radon are determined essentially by the conditions in the tail. To interpret the experimental results, a mathematical model was constructed; experimental and theoretical data were in good agreement. (auth)

32536 INDUCTION OF MAMMARY NEOPLASIA AFTER IN VITRO EXPOSURE TO X-RAYS. Shellabarger, C. J. (Brookhaven National Lab., Upton, N. Y.). Proc. Soc. Exp. Biol. Med.; 136: 1103-6(Apr 1971).

Two blocks of mammary tissue were removed from each of 110 female rats. One was exposed to 800 R of x-rays under in vitro conditions while the other was sham irradiated. Both were separately grafted subcutaneously onto the back of the animal from whence the tissues came. All grafts were recovered up to 10 months later. Sixteen of the irradiated grafts developed mammary neoplasia while only one of the sham-irradiated grafts developed mammary neoplasia. (auth)

32537 COMBINED SURGICAL AND RADIATION INJURY. V. THE EFFECT OF BONE MARROW TRANSPLANTATION. Donati, R. M.; Stromberg, Lw. R.; Johnson, M. C. (St. Louis Univ. St. Louis Veterans Administration Hospital. Army Medical Center, Washington, D. C.). Experientia; 27: 246-7(15 Mar 1971).

Rats were divided into four groups of 32 each. One group was not irradiated and marrow transplanted; a second group was x-irradiated and given saline; a third group was irradiated and marrow transplanted; and the fourth group was not irradiated and given saline. The dorsal surface was wounded four days after irradiation and the wounds were measured at the time of wounding and regularly thereafter. The results of the wound contraction patterns are shown by means of a graph. There were no differences between the non-irradiated marrow transplanted or saline treated wound contraction patterns. The wounds of the irradiated animals demonstrated a marked initial enlargement of the wound to a size 90% greater than the original wound area as compared with a 25% enlargement in the non-irradiated animals. The results showed that bone marrow was necessary for the normal process of wound contraction. (H.L.W.)

32538 EFFECT OF X RADIATION AND OF NUCLEIC-ACID INHIBITORS ON THE RESPIRATION AND ATP CONTENT OF THE EMBRYOS OF COBITIS FOSSILIS. Nikol'skaya, I. S.; Grudnitskii, V. A. (Inst. of Evolution Biology, Moscow). Dokl. Akad. Nauk SSSR; 194: 478-80(11 Sep 1970). (In Russian).

There is reason to believe that reduction of the ATP and increase in the rate of respiration during the growth of the embryo are related to the synthesis of nucleic acids. This assumption was further examined by studying the effects of x radiation and of agents that inhibit the synthesis of nucleic acids on respiration and ATP level of Cobitis fossilis embryos. The inseminated eggs were incubated at 14°C to the early gastrula stage. The oxygen consumption of embryos was determined with a Warburg apparatus at 21°C. The embryos were irradiated with a total dose of 40,000 R. Fluorouracil and actinomycin D were used to inhibit the DNA and RNA synthesis, respectively. MacElroy and Strehler's luminescence method was used to determine the ATP content. The x irradiation and use of inhibitors yielded similar results: they reduced the intensity of respiration and raised the ATP content. This was probably due to the effect that both agents depressed the synthesis of nucleic acids. As ATP is not only a source of energy but one of the substrates present during the synthesis of nucleic acids, its content in the embryos increased thereby; this in turn depressed the respiration. (TTT)

32539 FINE STRUCTURE OF ALVEOLAR AREAS IN THE LUNG FOLLOWING INHALATION OF $^{239}PuO_2$ PARTICLES. Sanders, Charles L.; Adee, Roy R.; Jackson, Thelma A. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Arch. Environ. Health; 22: 525-33(May 1971).

Rats exposed to $^{239}PuO_2$ aerosol showed a progressive increase in number and in detachment of type 2 alveolar epithelial cells. Large numbers of lipid droplets were found in septal cells by 30 days. A large exudate comprised of myeloid bodies, cell debris, and a protein-like material was found in the alveolar lumens at 20 days. This stage was followed by an accumulation of histiocytes, which engulfed a large part of the exudate. Destruction of endothelium and accumulation of septal cells, collagen, and elastin were common early findings. Alveolar septa were greatly thickened by 40 days due to edema, connective tissue formation, and accumulation of septal, mast, and plasma cells. Damage to type 1 alveolar epithelium was commonly seen only in the terminal phase of radiation pneumonitis. (auth)

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32540 LIGHT- AND ELECTRON-MICROSCOPIC FINDINGS IN LIVER TISSUE OF RABBITS FOLLOWING HIGH DOSES OF ^{60}Co IRRADIATION. Moellmann, H.; Reisch, J.; Alfes, H.; Meyborg, F. (Westfaelische Wilhelms Univ., Muenster, Ger.). Strahlentherapie; 140: 525-32(Nov 1970). (In German).

Early changes in hepatic tissue following high-dose ^{60}Co whole-body γ irradiation were examined light- and electron-microscopically. The examinations were carried out in 24 rabbits, weighing about 2 kg, which were irradiated 45 to 50 min by a ^{60}Co radiation dose of 30,000 rad continuously two hours after exposure to radiation. During these examinations, early changes due to irradiation of the hepatic tissue as well as of the ultrastructure of the hepatic cells were found. The early changes increased in accordance with the increase in survival time of the examined animals until two hrs. after exposure. Alterations in the cytoplasmatic basis structure, EPR, mitochondria, lysosomal structures, nucleus, glycogen, lipoid content of the hepatic cells were observed. (auth)

32541 IMMEDIATE AND DELAYED EFFECTS OF 1000 R X-RAYS ON THE RODENT TESTIS. Rugh, Roberts; Skaredoff, L. (Columbia Univ., New York, N. Y.). Contract AT(30-1)-2740. Fert. Steril.; 22: 73-82(Feb 1971).

A total of 64 control, 198 immediate and 191 second generation implantations were examined for the effects of x radiation on the testes of the male mouse, including CF1-S and C57BL/6 strains. The study dealt with the effects of 1000 R coned to the testes only, as revealed in matings with normal females of the same strain as well as with females of the C57BL/6 strain. Brother-sister matings of offspring gave data on second generation effects. The criteria of interest were: duration of successful pregnancies on days following radiation exposure; average number of implants per pregnancy; and percentage normals, dead, resorptions, and anomalies. There was no immediate effect of radiation on the fertilizing ability of mature spermatazoa. From Day 9 on males tended to become sterile, as judged by the presence of plugs but no ensuing pregnancy. Matings between (CF1-S) males and females of another strain (C57BL/6) tended to be less affected than when females of the same strain were used. This may be a demonstration of heterosis affecting early development. Resorption percentages were greater when the exposed male involved females of the same strain, and least when there was a heterozygous cross. This again suggests heterosis. The average number of implants was least affected when the CF1-S × CF1-S crosses were made, and most when C57BL/6 mice were used. Normality of offspring of exposed x-rayed fathers was always greater when heterozygous matings were involved. (F.M.M.)

32542 EXPERIMENTAL STUDY ON THE RADIOBIOLOGY OF THE RETICULOENDOTHELIAL SYSTEM. Castillo-Ramirez, A. Arch. Fac. Med. Zaragoza; 16: No. 1, 17-47(1968). (In Spanish).

The variations of the reticulo-endothelial system under the effects of lethal x radiation were examined in the common domestic rabbit by investigation of the phagocytic capacity of the liver and variations of the plasma proteins. The experimental procedure is described. The results showed that the phagocytic capacity does not undergo deterioration under 100% lethal irradiation until the 8th day. From the third to the seventh day, a distinct increase in the hepatic phagocytic activity was observed. This was attributed to the appearance of a polyblastic cell more differentiated and more phagocytic than the Kupffer cell. After the 8th day, a significant depression of the reticulum was observed. This was found by a decrease in the number of Kupffer cells and also by a disparity between the number of histocytoid cells in the sinusoids in comparison with the normal histological picture. (J.S.R.)

32543 EVOKED CORTICAL POTENTIALS IN PRENATALLY IRRADIATED RATS. Berry, M.; Eayrs, J. T. (Univ. of Birmingham, Eng.). Exp. Neurol.; 28: 426-41(Sep 1970).

Direct cortical, callosal, specific-sensory, and interhemispheric responses were evoked in the mature cortex of rats x irradiated on the nineteenth and twenty-first days of gestation (a procedure that prevented the development of layers II, III, and IV). In general, responses recorded from the cortex of animals irradiated on the twenty-first day of gestation exhibit increased conduction velocities, lowered thresholds, and raised amplitude. Threshold was also lowered in rats irradiated on the nineteenth day of gestation although the recorded responses tended to be very variable and to demonstrate normal or lowered amplitude and slowed or normal conduction velocities. The afterdischarge of responses in both groups of animals remained normal and appeared to be conducted without decrement over the distances studied. Attenuation of the direct response with distance from the point of stimulation was increased as a result of irradiation on the nineteenth day of gestation but was normal in the group irradiated later in life. (auth)

32544 RELATIONSHIP BETWEEN PRPP SYNTHESIS AND NAD SYNTHESIS IN RABBIT ERYTHROCYTES AFTER X-RAY IRRADIATION. Filip, M.; Chisleag, Gh.; Ionescu, M.; Ababei, L. (Inst. of Medicine, Iasi). Rev. Roum. Biochim.; 7: 257-63(1970).

The erythrocyte hemolysate from irradiated animals has a higher nicotinamide-adenine dinucleotide (NAD) synthesis capacity than that of non-irradiated animals. After irradiation, ribosephosphate pyrophosphokinase (PRPP-kinase) activation and PRPP accumulation were observed in the red blood cells. 5-phosphate 1-pyrophosphate ribose (PRPP) accumulation can be attributed to a decrease in the capacity of the cells of irradiated animals to use this intermediary in the synthesis of purine and pyrimidine nucleotides. In the hemolysate of irradiated cells the limiting factor in NAD synthesis, under conditions of saturation with nicotinamide or nicotinic acid, appeared to be R5P (ribose-5-phosphate). The stimulating effect of methylene blue on NAD synthesis in the hemolysate of both normal and irradiated animals was attributed to the stimulation of R5P synthesis. Nicotinamide and nicotinic acid protected NAD synthesis to the same extent in the presence of R5P in irradiated erythrocytes. (auth)

32545 ANTIBODY FORMATION BY TRANSFERRED PERITONEAL CELLS AND SPLEEN CELLS OF MICE. II. TRANSFER OF PERITONEAL CELLS FROM IMMUNIZED IRRADIATED DONORS TO SYNGENEIC RECIPIENTS WITH AND WITHOUT ANTIGEN. Kornfeld, Lottie; Weyzen, Walter W. H. (Naval Radiological Defense Lab., San Francisco). RES. J. Reticuloendothel Soc.; 9: 162-73(Feb 1971).

Peritoneal cells from mice immunized with sheep red blood cells synthesized hemagglutinins after transfer to syngeneic x-irradiated recipients either with or without a concomitant injection of antigen. In recipients not given antigen, peritoneal cells from mice exposed to 600 R total-body x irradiation 4 hours after the last immunization formed as much antibody as did an equal number of peritoneal lymphoid cells from nonirradiated donors. However, the antibody-forming capacity of peritoneal cells from mice irradiated 24 hours before or 12 to 72 hours after immunization was greatly impaired. In recipients that were injected with antigen, peritoneal cells from irradiated and nonirradiated donors produced essentially equal amounts of antibody. These results are interpreted as lending further support to the idea that at least two types of cells, present in the peritoneal cavity of immunized mice and classified morphologically as lymphocytes, are capable of developing into antibody-forming cells after transfer: memory cells that are relatively resistant to x irradiation and develop rapidly in the presence of antigen into cells that form primarily mercaptoethanol (ME)-resistant antibodies, and determined cells that are sensitive to irradiation and develop more slowly in the absence of antigen into cells that produce mostly ME-sensitive antibodies. (auth)

32546 INFLUENCE OF CORTISONE ON THE EARLY REACTION OF THE LUNG IN IRRADIATED RATS. Bergamini, G.; Pini, M.; Fazio, G. (Ospedale Maggiore, Trieste, Italy). Minerva Med. Giuliana; 9: 16-19(Jan-Feb 1969). (In Italian).

The histological evidence of the lungs of rats irradiated at a dose of 2000 R and treated with cortisone alone or in conjunction with the antibiotic quadriciclin, both before and after irradiation, is reported. The histological data show how the cortisone modified the reactivity of the irradiated tissue causing an inflammation response primarily of the histiocyte type with lymphocyte and exudation component decrease. There was no acceleration of the interstitial sclerotization processes which were a late reaction to the radiation injury of the lung parenchyma. (tr-auth)

32547 BLOOD LIPID PEROXIDES INDUCED BY ^{198}Au INTRAPERITONEAL IRRADIATION OF THE RABBIT. Carton, M.; Landreaud, B.; Douste-Blazy, L. (Hospital de La Grave, Toulouse). Compt. Rend. Soc. Biol.; 163: 1212-16(11 Dec 1969). (In French).

Localized irradiation caused by the intraperitoneal injection of ^{198}Au into rabbits resulted in the same high elevation of blood lipids as whole-body external irradiation. The rate of blood lipid peroxides was increased significantly during this irradiation. The two phenomena, hyperlipemia and elevation of lipid peroxides, appeared independent of each other. (tr-auth)

32548 VARIATIONS IN THE OXIDO-REDUCTION POTENTIAL OF VENOUS BLOOD IN X-IRRADIATED RABBITS. Meyniel, G.; Le Chapelain, C.; Abitboul, J.; Gaillard, G.; Berger, J. A.

XUM

(INSERM, Clermont-Ferrand, France). Compt. Rend. Soc. Biol.: 163: 1142-5(11 Dec 1969). (In French).

In vivo studies were made of the variations of the oxido-reduction potential of venous blood of rabbits irradiated at x ray doses of 600 and 1200 R. The statistical evaluations affirmed that irradiation by x rays increases the value of the oxido-reduction potential for exposures over 600 R. This increase was especially noticeable at the plateau of the redox curve. It appeared that the modifications of the redox potentials were not directly proportional to the exposure. The variations of the potential were modified as a function of time. (J.S.R.)

32549 INFLUENCE OF X-RAYS IRRADIATION OF THE HEAD ON THE NEUROSECRETORY CELLS IN GRYLLUS DOMESTICUS L. Theodorescu, Maria; Novak, Vladimir J. A. (Univ., Bucharest, Inst. of Entomology, Prague). Acta Entomol. Bohemoslov.; 67: 207-10(1970). (In French).

X irradiation gives optically observable effects in the insects Gryllus domesticus only if it is applied in very strong doses, 50,000 or 500,000 R. If the doses are weaker (100 R), the effect produced abruptly causes a massive elimination of the neuron secretation, but this action does not last, the effect is not persistent, and the cells regain their function. Very strong doses release morphological changes: vacuolization, almost complete elimination or agglutination of the secretation, and picnotic degeneration of the eyes. These doses can be considered as dangerous because their structural effect is more persistent even if cells in secretion can be found 48-hr after irradiation. (tr-auth)

32550 RADIOBIOLOGICAL CONTRIBUTIONS TO THE PROBLEM OF PARTIAL BODY RADIATION UNDER CONDITIONS OF HYPERBARIC OXYGEN AND ADMINISTRATION OF A CYTOSTATIC (PRORESID). PART 2. Loehr, E.; Goebbeler, Th.; Magnus, L. (Roentgeninstitut und Strahlenklinik, Essen). Strahlentherapie; 140: 406-27(Oct 1970). (In German).

The influence of telecobalt irradiation with hyperbaric oxygen was studied on the carbohydrate and electrolyte metabolism of the bone marrow of the rat. Under the same conditions, the influence of the drug Proresid was studied. Hyperbaric oxygen alone caused lesions of the carbohydrate and electrolyte metabolism of the bone marrow cells. Under these experimental conditions, the cells irradiated in hyperbaric oxygen presented more extensive lesions and recovered more slowly than after an irradiation under normal conditions. Organs that were not irradiated were also studied. No histological lesion was observed in the liver and in the kidneys after an irradiation either under hyperbaric or under normal conditions. The modifications in the spleen after hyperbaric irradiation were not specific. Hyperoxygenation resulted in a temporary accumulation of fat in the hepatic cells. This accumulation was even more pronounced after a partial irradiation. When Proresid was given, the accumulation was more pronounced when the drug was administered every day after an irradiation under hyperbaric oxygen. Proresid alone only resulted in minor modifications in the glycolytic enzymes and on the electrolyte metabolism. These changes evolved to a profound dehydration when the drug was administered during a long time, but they were reversible when the administration was ceased. The study of the different organs showed that the hyperbaric oxygenation also caused lesions in the non-tumorous tissues. In bone marrow these lesions were largely the same as after an irradiation. (auth)

32551 EFFECTS OF γ-IRRADIATION UPON MONOAMINE OXIDASE ACTIVITY. Diaz Borges, J. M.; Drujan, B. D. (Instituto Venezolano de Investigaciones Cientificas, Caracas). Radiat. Res.; 45: 589-97(Mar 1971).

A decrease in the liver monoamine oxidase (MAO) activity in both fish and mice occurred on the third day after a single dose of 2 krads of γ irradiation. This decrease paralleled the development of radiation disease. A dose-dependent increase was observed in different organs of the fish (liver, kidney, heart, brain, and retina) immediately after irradiation. This increase was not permanent and it could be demonstrated when the enzymatic activity was measured in vivo or in vitro. Since this increase was not observed in irradiated isolated organs, the influence of a possible indirect factor is proposed. In mouse spleen where a marked loss of organ weight occurred, a selective retention of the enzyme is suggested to explain the observed increase of the activity per gram of tissue. In the kidney, heart, and brain of the mouse no changes in MAO activity could be found. (auth)

32552 LETHAL AND HEMATOLOGIC EFFECTS OF 14.6 MeV NEUTRONS ON BEAGLES WITH ESTIMATION OF RBE. Earle, John D.; Ainsworth, E. John; Leong, George F. (Naval Radiological Defense Lab., San Francisco). Radiat. Res.; 45: 487-98(Mar 1971).

Beagles were exposed in plywood boxes to 14.6 MeV neutrons from Lawrence Radiation Laboratory's insulated core transformer. Hematologic response was followed in a small group and the $LD_{50(30)}$ determined in 82 dogs. The $LD_{50(30)}$ for 1 MVp x rays was confirmed with similar dogs from the colony, irradiated and maintained under nearly identical conditions. Neutron dosimetry was performed utilizing an appropriate phantom. The hematologic response to 189 rads midline exposure volume dose (MEVD) or 136 rads midline tissue dose (MTD) of 14.6 MeV neutrons is presented. The $LD_{50(30)}$ was 379 rads (MEVD) with 95% confidence limits 349 to 461 rads (MEVD) based on 82 dogs, while the corresponding values for x-ray were 326 R (363-295) (MEVD) utilizing 24 dogs. Dosimetric data are presented in support of the estimate of neutron $LD_{50(30)}$ of 281 rads (MTD) (including 3% γ-ray contribution) compared with x-ray $LD_{50(30)}$ of 288 rads (MTD). Thus the RBE of 14.6-MeV neutrons compared to 1 MVp x rays is 1.01. These results are discussed and compared with previous neutron irradiation results in dogs. (auth)

32553 BONE MARROW, SPLEEN, AND THYMUS REGENERATION PATTERNS IN MICE AFTER WHOLE-BODY IRRADIATION. Takada, Akikazu; Takada, Yumiko; Kim, Untae; Ambrus, Julian L. (Roswell Park Memorial Inst., Springville, N. Y. Roswell Park Memorial Inst., Buffalo). Radiat. Res.: 45: 522-35(Mar 1971).

In mice subjected to whole-body x irradiation, spleen weight decreased soon after exposure, but rapid regeneration occurred after day 10. Injection of 5×10^6 bone marrow cells (BMC) after irradiation, or shielding of the right femur during irradiation, was followed by early recovery. Shielding the right femur had the same general effect as did injection of BMC; but cells that migrated from the bone marrow to the spleen in the shielded mice started to synthesize hemoglobin immediately, whereas injected bone marrow cells neither synthesized hemoglobin nor divided for as long as 2 days after irradiation and injection. These findings may mean that the spleen requires stem cells from the bone marrow for recovery from radiation injury. Recovery may be delayed until the irradiated bone marrow can seed the spleen with a sufficient number of stem cells. Then regeneration occurs rapidly. (E.E.H.)

32554 DOSE RATE FACTOR FROM INTERSTITIAL IRRADIATION WITH ^{103}Pd AND ^{109}Pd. Ariel, Irving M.; Robertson, James S. (Brookhaven National Lab., Upton, N. Y.). Surg. Gynecol. Obstet.; 132: 817-31(May 1971).

New Zealand white rabbits received liver injections of 80 mCi of ^{109}Pd. The radiation dose delivered at the time of histological examination 4 days later was computed to be 0.227×10^6 rads. The examination revealed a large diffuse area of acute necrosis. Immediately adjacent to the necrotic area, the hepatic cells appeared to be normal. Another series of rabbits were given liver injections of 10 mCi of ^{103}Pd each which delivered a calculated dose of 1.398×10^6 rads when examined 60 days later. The liver appeared normal and no detectable histological abnormalities were found. Rabbits given combined doses of 40 mCi of ^{109}Pd and 10 mCi of ^{103}Pd showed a grossly normal liver 17 days later, but histological examination revealed a large necrotic area. The data demonstrate that the time-intensity factor from irradiation is extremely important. Normal hepatic regeneration occurs in the presence of slowly delivered radiation with long-acting isotopes. These observations are consistent with similar observations following external radiation. Clinical use of these isotopes for tumor therapy showed that the intestitial administration of the combined isotopes may be the most desirable method. (E.E.H.)

32555 PECULIARITIES OF PRETUMOR AND TUMOR PROCESSES IN OVARIES OF MICE IRRADIATED WITH LARGE DOSES. Aleksandrov, S. N.; Gubareva, A. V.; Galkovskaya, K. F. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 17: No. 1, 51-4(1971). (In Russian).

The ovaries of a large group of non-pedigree mice, subjected to total ^{60}Co γ irradiation in doses 600, 900, 1100, and 1200 rad and saved from death by means of bone marrow transplantation were investigated. Autotransplantation of the bone marrow did not change the course of blastomogenesis in ovaries of irradiated mice and did not affect the frequency of development of neoplasms. Reduction in the number of ovarian tumors in mice, irradiated with a dose of 1100 rad (animals irradiated with a dose of 1200 rad did not survive till the carcinogenic period of development of gonadal tumors), was mainly related to inhibition of gonadotropic activity of the hypophysis. The latter was the cause of both a continuous atrophic state of thecal tissue in sterile ovaries and its insignificant participation in tumor formation. (auth)

32556 EFFECT OF NEUTRON-GAMMA RADIATION ON THE MORPHOLOGY OF THE MUCOSA OF THE SMALL INTES-

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TINE OF GERMFREE AND CONVENTIONAL MICE. Jervis, Helen R.; McLaughlin, Mary M.; Johnson, Merrill C. (Walter Reed Army Medical Center, Washington, D. C.). Radiat. Res.: 45: 613-28(Mar 1971).

Matched groups of ICR conventional (Conv) and germfree (GF) mice received neutron–gamma irradiation of 375 or 1000 rads, causing lesions in the small intestine. These developed faster in Conv than in GF mice. After the lower dose, mucosal regeneration occurred earlier in Conv than in GF mice, but mucosal recovery in both groups was complete before death. After 1000 rads, atrophy of villi became severe within 4 days in Conv and 5 to 6 days in GF mice, coinciding with the onset of diarrhea, followed by death one day later. At death the mucosa in both groups of animals was identical; no denudation was present but the epithelium of the atrophic mucosa consisted of abnormal cells. Neutron–gamma irradiation of GF mice therefore resulted in a mucosal response which was similar in nature to that observed in Conv mice, although somewhat delayed in its development. At the higher dose, the longer survival in GF mice correlated with the slower rate of development of mucosal lesions, which in turn appeared to be related to slower turnover time of the epithelium of the GF intestinal mucosa. (auth)

32557 EFFECTS OF X-RAYS ON THE SYNTHESIS OF DNA, RNA, AND PROTEINS IN SYNCHRONIZED CHINESE HAMSTER CELLS. Bacchetti, Silvia; Sinclair, Warren K. (Argonne National Lab., Ill.). Radiat. Res.: 45: 598-612(Mar 1971).

The effects of x rays on DNA, RNA, and protein synthesis were studied, using radioactive precursors, during one or two consecutive synchronous cycles of Chinese hamster cells irradiated at different stages. The results obtained for DNA synthesis showed that maximum effects are induced when the cells are irradiated in S phase. When cells were irradiated in G_1 or G_2 phase, DNA synthesis was essentially unaffected in subsequent cycles except for division delay. Irradiated cells were stimulated to synthesize RNA and proteins at a higher rate than the control. The stimulation was more pronounced for protein than for RNA synthesis and greatest for cells irradiated in G_1 phase. The extent of the stimulation in irradiated G_2 cells, however, was difficult to determine due to decay of synchrony and division delay. Addition of 50 μg/ml of cycloheximide for 3 hours after irradiation of G_1 and G_2 cells protected the cells to some extent against the loss of colony-forming ability and inhibited the overall synthesis of DNA, RNA, and proteins. After removal of the drug, the cells recovered only partially their normal level of synthesis and no indication of unscheduled metabolic activity was observed during the subsequent cycle. These observations are discussed together with other data obtained on the effects of x rays and cycloheximide on division delay. (auth)

32558 HEMOPOIETIC STEM CELLS AS A FUNCTION OF ERYTHROPOIESIS. Fogh, Jan (Univ. of Chicago. Univ. of California, Berkeley). Radiat. Res.: 45: 563-76(Mar 1971).

The content of hemopoietic stem cells was measured in two groups of mice with extremely different erythropoietic activity but with identical hematocrit values and red cell volume per 100 g of body weight. Influences on the results of the stem cell assays of factors related to red cell mass, other than the level of erythropoietic activity, were thereby equalized for the two groups. The 30 day survival rate, the number of endogenous spleen colonies, and the rate of erythropoietic recovery following x irradiation were substantially increased in mice with increased erythropoietic activity as compared to mice in which erythropoiesis had ceased at the time of the stem cell assay. It was concluded that an increase in erythropoietic activity is associated with an increase in the total number of hemopoietic stem cells in an animal. The concentration of stem cells in femoral bone marrow was identical for the two experimental groups. It is suggested that an increase in the total number of stem cells is accomplished by an increase in the number of stem cells of the spleen. (auth)

32559 COMPOSITION AND PROPERTIES OF FETAL PROTEINS IN PRENATAL ROENTGEN IRRADIATION. Zhakhova, Z. N.; Lopatina, N. I.; Yur'ev, V. A. (Inst. of Gynecology and Obstetrics, Moscow. Leningrad Inst. of Pediatrics). Med. Radiol.; 16: No. 3, 59-64(Mar 1971). (In Russian).

Roentgen irradiation of gravid female rabbits caused noticeable changes in the composition and properties of proteins of the skeletal musculature of fetuses. Lagging of the normal process of biochemical maturation of the fetal muscular tissue was noted. Shifts in the content and properties of the proteins of the fetal skeletal musculature were also observed testifying to an earlier maturation of individual protein fractions. (auth)

32560 RELATIVE BIOLOGICAL EFFECTIVENESS OF FAST ELECTRONS GENERATED BY LUE-25 LINEAR ACCELERATOR. Kozlov, A. P.; Akimov, A. A.; Skachkov, A. P. (Leningrad Research Inst. of Oncology). Med. Radiol.; 16: No. 3, 69-71(Mar 1971). (In Russian).

The relative biological effectiveness (RBE) of fast electrons was determined in mice by the LD-50/30, LD-50/4, and by atrophy of the spleen and thymus, as well as by inhibition of the growth of Ehrlich's tumor and planocellular cancer of the skin. By all the criteria the RBE of fast electrons (16.5 MeV) in comparison with roentgen radiation (200 keV) was less than one. (auth)

32561 VENOUS AND LYMPHATIC CHANNEL UNDER CONDITIONS OF IONIZING RADIATION. Khudaiberdyev, R. I.; Kulikov, Yu. A.; Nurmukhamedov, B. N. (Tashkent Medical Inst.). Med. Radiol.; 16: No. 3, 50-3(Mar 1971). (In Russian).

Following single irradiations with a dose of 400 R to rabbits, restoration of the blood outflow after resection of fragments of major femoral veins occurred within 110 to 120 days, whereas in experiments without irradiation it was restored within 60 to 90 days. There was a significant deceleration of the lymphatic outflow. In experiments without irradiation, a complete restoration of the lymph outflow after extirpation of popliteal lymph nodes occurred in 6 months. During radiation sickness a complete restoration of the lymph outflow was not noted even after one year. (auth)

32562 TECHNIQUE OF CONCENTRATED IRRADIATION OF THE ESOPHAGUS (EXPERIMENTAL RESEARCH). Simbirtseva, L. P.; Stegailov, R. A.; Neishtadt, E. L.; Terpugov, V. G. (Leningrad Inst. of Oncology). Med. Radiol.; 16: No. 3, 10-15 (Mar 1971). (In Russian).

Studies were made on dogs following local irradiation of the esophagus by means of mobile roentgen therapy with a dose of 2000 R fractionated (700, 700, and 600 R) for seven days. Morphological studies conducted for two months after irradiation revealed no noticeable changes in the surrounding healthy organs, as well as in the principal hematopoietic organs, gastrointestinal tract, liver, pancreas, and kidneys. (auth)

32563 MITOTIC INDEX OF MYELOID CELLS IN IRRADIATION DOSIMETRY. Giraldi, A.; Carco, F. P.; Giraldi, M.; Cerra, E. (Univ., Pavia, Italy). Arch. Vecchi Anat. Patol. Med. Clin.; 51: 473-90(May 1968). (In Italian).

The mitotic index of bone marrow cells removed from the femur of chicks following exposure to various doses of whole-body x radiation (500, 1000, and 15000 rad) was evaluated for use as a biological dosimeter. The number of cells in mitosis per 1000 bone marrow cells were counted at various times following irradiation and comparison was made with mitosis in bone marrow cells from non-irradiated controls. Results showed that following irradiation the mitotic index decreased rapidly during a 12-hour period in response to the radiation dose and returned to that of the controls by the 21st hour following irradiation. It was concluded that the mitotic index of bone marrow cells could be used as a biological dosimeter during the 12-hour period immediately following irradiation. (TSS)

32564 CORTISONE-INDUCED CHANGES IN REACTIVITY OF THE IRRADIATED LUNG. EXPERIMENTAL RESEARCH. Bergamini, G.; Pini, M.; Fazio, G. (Univ., Turin. Ospedale Maggiore, Trieste, Italy). Riv. Patol. Clin. Sper.;9: 417-24 (Jul-Sep 1968). (In Italian).

Rats were given intraperitoneal injections of 0.2 cc of cortisone solution for six days before exposure of the lung region to 2,000 rad x radiation. The animals were sacrificed at various times up to 40 days post-irradiation. Respiratory tract tissues were examined histologically and the findings were compared with those of irradiated non-cortisone treated controls. Tissue damage was much more severe in the cortisone-treated animals, with massive pneumonitis observed on the fourth post-irradiation day, atrophy of intra-alveolar membranes evident by the 20th day, and extensive sclerosis evident by the 40th day. The implications of the findings in the administration of cortisone to patients with lung neoplasms either before or following radiotherapy are discussed. (C.H.)

32565 EFFECTS OF RADIATION ON ZINC METABOLISM OF SHEEP. Sasser, L. B.; Bell, M. C.; Wade, L. Jr.; Jarboe, G. E. (UT–AEC Agricultural Research Lab., Oak Ridge, Tenn.). Contract AT(40-1)-GEN-242. Radiat. Res.; 46: 115-28(Apr 1971).

Erythrocytes from 64 sheep given either a single γ exposure to the whole body (240 R), a single beta dose to the skin (57 krads), an ingested dose of ^{90}Y-labeled sand (2.4 mCi/kg body weight), or

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combinations of these three treatments were incubated with ^{65}Zn and the percentage erythrocytic ^{65}Zn uptake was determined. Concentrations of stable zinc in plasma and erythrocytes were also measured. In vitro uptake of ^{65}Zn by erythrocytes of gastrointestinal and skin-irradiated sheep was higher than that of control sheep, but stable Zn content of erythrocytes was unaffected. Plasma Zn concentration was decreased ($P < 0.05$) by skin irradiation, but not by gastrointestinal or whole-body irradiation. Five skin-irradiated and two control sheep were intravenously dosed with ^{65}Zn one year after irradiation and the turnover rate of Zn and tissue distribution of ^{65}Zn were measured. The turnover rate of Zn in plasma was 4.8 mg/day per kilogram in skin-irradiated sheep and 6.9 mg/day per kilogram in control sheep. Urinary excretion of ^{65}Zn by skin-irradiated sheep was increased, while fecal ^{65}Zn was reduced the first day but unchanged over the total 10-day collection period. The injury produced by the radiation was probably responsible for the increased uptake of ^{65}Zn by the erythrocytes rather than a direct effect of radiation to the erythrocyte or change in dietary Zn levels. The injury may have caused a shift of plasma proteins (a higher fraction of globulins) affecting the availability of Zn to the erythrocyte or altered the affinity of erythrocytes for Zn. (auth)

32566 AUTOLOGOUS BONE MARROW TRANSPLANTATION IN IRRADIATED BABOONS. Chertkov, J. L.; Sukyasyan, G. V.; Novikova, M. N.; (and others) (Central Inst. of Hematology and Blood Transfusion, Moscow). Radiat. Res.; 46: 129-43(Apr 1971).

Lethal acute radiation sickness produced in baboons by whole-body γ irradiation with exposures of 900 to 1500 R was marked by rapidly progressing marrow aplasia, a severe hemorrhagic syndrome, and infections. After this irradiation level the survival time did not exceed 10 to 16 days. Autologous bone marrow transplantation produced no beneficial effect in monkeys exposed to 1500 R. With irradiation ranging between 900 and 1100 R, autotransplantation of bone marrow in doses of 2×10^8 cells/kg and higher afforded effective protection from acute radiation death. The hemopoietic tissue regenerated within six to eight weeks. Erythro-, granulo-, and thrombopoiesis were restored by this time and the blood lymphocyte content became normal. The time of allogeneic skin graft rejection in supralethally irradiated baboons protected by autologous bone marrow transplantation was prolonged by three to five days compared to normal animals. Antibody production in response to the Vi-antigen was suppressed in control irradiated baboons and sharply reduced and inhibited in those given bone marrow. (auth)

32567 ALLOGENEIC BONE MARROW TRANSPLANTATION IN IRRADIATED BABOONS AND MONKEYS. Chertkov, J. L.; Nemenova, N. M.; Samoylina, N. L.; (and others) (Central Inst. of Hematology and Blood Transfusion, Moscow). Radiat. Res.; 46: 144-64(Apr 1971).

Allogeneic hemopoietic cells given to the irradiated baboon or Macaca monkey transform by way of typical hyperbasophilic forms to lymphoid cells which cause a fatal acute secondary disease. This is characterized by an especially rapid course in the baboon, Papio hymadryas. Morphological studies revealed the similarity of these cells to cellular elements that occur in reactions of transplantation immunity. The lymphoid cells undergo rapid degeneration, apparently with allergic death of immunologically competent cells in the presence of excess antigen. Preliminary thymectomy considerably mitigated the course of acute secondary disease in monkeys and facilitated regeneration of donor-type hemopoiesis. It is, therefore, possible that hemopoietic stem cells may take part, along with more mature immunologically competent cells, in the production of an acute reaction or graft-versus-host type. Poor bone marrow repopulation in primates with xenogeneic transplants was seen. Multiple chromosome aberrations were found in nonirradiated cells of the grafted bone marrow. (auth)

32568 EFFECTS OF 14 MeV NEUTRONS AND X RAYS, SINGLY OR COMBINED, ON THE REPRODUCTIVE CAPACITY OF L CELLS. Masuda, Kouji (Kyushu Univ., Fukuoka). J. Radiat. Res.; 11: 107-12(Sep-Dec 1970).

In order to determine if the effects of neutrons on mammalian cells are qualitatively different from those of x- or γ-rays, L cells were irradiated with D-T neutrons and 180 kvp x rays, singly or combined. From analysis of dose response curves, it was concluded that the cell killing mechanism of neutrons was not the same as that of x ray, but there was something common in part between them. RBE values for neutrons with respect to x rays calculated from dose curves were 2.5 to 1.5 for 50 to 1% survival. (auth)

32569 EFFECTS OF X IRRADIATION ON EVOKED POTENTIALS FROM VISUAL SYSTEM IN RABBITS. Minamisawa, Takeru; Sugiyama, Hiroshi; Tsuchiya, Takehiko; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 11: 127-33(Sep-Dec 1970).

The effects of x rays on the visual system were electrophysiologically studied in rabbits that were subjected to 250 R or 500 R or head-only irradiation. Three types of the evoked potentials that were elicited in the visual cortex and in the lateral geniculate body by photic stimulation and in the visual cortex by electrical stimulation to the lateral geniculate body were recorded up to 10 days following irradiation. The amplitude and the duration of the evoked potential from the visual cortex by photic stimulation decreased and reached a minimum value 8 hours after irradiation. This was immediately followed by a gradual increase in amplitude and duration to levels close to the control on the first day, but the return to control was not complete, even at the end of 10 days. These reductions were more marked after irradiation of 500 R than that of 250 R. The changes of the two other potentials were very similar to that elicited in the visual cortex by photic stimulation. These results can be attributed to a depressing influence of x rays on the whole visual system. This finding draws further attention to the fact that these potentials depend on events occurring in the reticular formation. Some implications of the effects of x rays on the rabbit visual system are discussed. (auth)

32570 EFFECT OF CIRCADIAN RHYTHM ON THE RADIOSENSITIVITY OF THE ROUGH-SKINNED NEWT (TARICHA GRANULOSA). Lappenbusch, William L. (Environmental Protection Agency, Rockville, Md.). J. Radiat. Res.; 11: 134-7 (Sep-Dec 1970).

The radiosensitivity of the salamander irradiated with 1,000 R and stored at 15°C was found to fluctuate drastically over a 24-hour period, the greatest change in survival times occurring between 9:00 pm and midnight. Radiosensitivity appeared to be related to the light–dark cycle and to the circadian rhythm previously noted in these and other animals. The results clearly emphasized the importance of reporting the exact time of day in which radiation exposures are administered to Taricha granulosa and perhaps other animals. (auth)

32571 EFFECTS OF PRE-NATAL X IRRADIATION ON THE VISUAL EVOKED POTENTIAL IN ADULT RABBITS. Minamisawa, Takeru; Sugiyama, Hiroshi; Tsuchiya, Takehiko; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 11: 151-6(Sep-Dec 1970).

The visual evoked potential of adult rabbits, who had been irradiated with 75 R of x rays on the 11th day of gestation, was studied. The effects of Nembutal on the evoked potentials were also investigated. Three types of evoked potentials, which were elicited in the visual cortex and in the lateral geniculate body by photic stimulation and in the visual cortex by electrical stimulation to the lateral geniculate body, were recorded before and 2, 3, 4, and 5 hours after injection of Nembutal. No significant difference in the visual evoked potential was observed between the irradiated and the non-irradiated animals, but the effect of Nembutal on this potential was slightly smaller for the irradiated animals. The results suggest that the activity of the reticular formation in the irradiated animals may have been affected by the radiation. (auth)

32572 EFFECT OF INTERNAL EXPOSURE BY ^{90}Sr AND ^{131}I ON RESPIRATORY $^{14}CO_2$ PATTERNS FOLLOWING ^{14}C-GLUCOSE ADMINISTRATION IN MICE. Matsuoka, Osamu; Muramatsu, Emiko; Kashima, Masatoshi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 11: 157-65(Sep-Dec 1970).

The effects of internal irradiation by ^{90}Sr and ^{131}I were compared using the ^{14}C-glucose oxidation test in mice. Mice were injected with 2 μCi/g body weight of ^{90}Sr or 5 μCi/capita of ^{131}I for internal irradiation. At one day or 1, 3, 6, or 9 weeks after injection of ^{90}Sr and one or seven days after injection of ^{131}I, the respiratory $^{14}CO_2$ patterns of the animals were studied by continuous measurements of $^{14}CO_2$ and CO_2 in the exhaled air. The time course pattern of specific activity was obtained by calculating the ratios of the observed value of $^{14}CO_2$ and CO_2. The effects of internal exposure on respiratory $^{14}CO_2$ were evaluated by the following parameters: peak time, i.e., the time from injection to maximum specific activity, and peak height, the maximum specific activity at peak time. In the control group, the value of specific activity of exhaled $^{14}CO_2$ increased immediately after ^{14}C-glucose administration, reached the maximum at 30 minutes, and then gradually decreased. Internal irradiation with ^{90}Sr caused a front shift, i.e., decrease in peak time with no appreciable change in peak height as compared

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with control. In the case of ^{131}I, the respiratory pattern underwent an upper shift, i.e., increase in peak height with no change in peak time. To clarify the mechanism of the phenomena obtained by these internal emitters, the effects of some drugs on the change of respiratory $^{14}CO_2$ pattern were studied. It is suggested that respiratory $^{14}CO_2$ pattern analysis may serve as a useful tool in the comparative study of the effects of various internal emitters. (auth)

32573 MORPHOLOGICAL CLASSIFICATION OF MAMMARY TUMOURS IN THE MOUSE. van Ebbenhorst Tengbergen, Wilhelminia, J. P. R. (Netherlands Cancer Inst., Amsterdam). Pathol. Eur.; 5: 260-72(1970).

More than 9000 spontaneous, chemically-induced, virus-induced, and x-radioinduced mammary tumors of inbred strains mice were classified according to their morphological types. When the incidence of acinar types was used a standard criterion for comparison, differences between treatments were found. This led to the hypothesis that in the mammary gland of the mouse different agents effective in mammary carcinogenesis act primarily either on the lobulo-alveolar system or on the milk duct system. (auth)

32574 MECHANISMS OF RADIATION-INDUCED CHANGES IN THE RABBIT'S VISUAL SYSTEM. Bakradze, O. S. (Inst. of Physiology, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR; 61: 157-60(Jan 1971). (In Russian).

The cortical evoked responses to visual stimuli disappeared following doses of 17 to 20 krad, while response to electrical stimulation of the lateral geniculate body (GL) or tractus opticus (TO) persisted till the death of the rabbits. The action of the irradiation on the electrically evoked responses from GL and TO was manifested in the initial decrease and subsequent abolishment of the negative component. (auth)

32575 OSTEOGENIC SARCOMAS IN MICE AFTER TRAUMA OF THE EXTREMITY AND WHOLE-BODY IRRADIATION. Gubareva, A. V.; Aleksandrov, S. N.; Galkovskaya, K. F.; Shimanovskaya, K. B. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 16: No. 12, 23-6(1970). (In Russian).

Three cases of osteogenic sarcomas developed in the region of the extremity stump in mice subjected to total irradiation immediately after crural amputation are reported. (auth)

32576 SIMPLE MATHEMATICAL MODEL FOR LIFE-SHORTENING BY RADIATION. Sato, Fumiaki; Nakamura, Wataru; Eto, Hideo (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 11: 145-50(Sep-Dec 1970).

Assuming a linearity of Gompertz function, the effects of radiation on the two parameters of Gompertz function were estimated for single or continuous exposure. The dependence of the two parameters on dose or dose-rate is given in analytic form. In the range of dose usually used in mice experiments, the percents of life-shortening yielded approximately the same values, irrespective of measures such as mean, median, or mode of survival time. The mathematical model describes the data on life-shortening, Gompertz function and daily death distribution with consistency. (auth)

32577 DNA SYNTHESIS AND RATE OF BONE MARROW CELL DIFFERENTIATION OF DOGS EXPOSED TO SIMULATED RADIATION OF EXTENDED SPACE FLIGHTS. Ilyukhin, A. V. Kosm. Biol. Med.; 4: No. 3, 36-40(May-Jun 1970). (In Russian).

The results of autoradiographic studies on the DNA synthesis and bone marrow cell differentiation in dogs exposed to prolonged ^{60}Co λ irradiation are given. The irradiation pattern simulated the environment in space cabins during extended space flights. The dogs were irradiated for 12 to 16 months. The tested parameters changed insignificantly and reversibly during single irradiations of the animals with 50 rem. No significant changes in the DNA synthesis or the rate of cell maturation occurred during chronic irradiation of the animals with total doses of 25, 75, and 150 rem per year. (auth)

32578 CHANGES IN OVARIAN INTRAVASCULAR COMPARTMENT PRIOR TO SUPEROVULATION IN X-IRRADIATED RATS. Hahan, Eric W.; Ward, William F. (Univ. of Rochester, N. Y.). Radiat. Res.; 46: 192-8(Apr 1971).

Ovarian retention of radioiodinated serum albumin (RISA) was used as an index of the intravascular compartment of that organ during the estrous cycle in normal rats and in animals exposed to a regimen of x irradiation known to induce superovulation (400 R whole-body at metestrus). In unirradiated animals, the intravascular space was highest on the morning of metestrus, decreased significantly during diestrus, then increased with the approach of the next estrus. In irradiated animals the large metestrus intravascular compartment persisted throughout the cycle. Choice of anesthesia significantly affected actual ovarian RISA retention, but not the pattern of change through the cycle. Possible role of this radiation response in radioinduced superovulation in the rat is discussed. (auth)

32579 FREQUENCY OF PARTHENOGENESIS IN CHICKENS AFTER INSEMINATION WITH IRRADIATED SPERM. Sarvella, Patricia (Dept. of Agriculture, Beltsville, Md.). Radiat. Res.; 46: 186-91(Apr 1971).

The parthenogenetic membranes appeared to increase in size following insemination with γ-irradiated sperm in a parthenogenetic line of chickens, but not in a nonparthenogenetic line. Irradiated sperm, given 20,000 rads, were viable but not capable of fertilization. They appeared to be effective in causing more or larger membranes but not more embryos. (auth)

32580 EFFECTS OF X IRRADIATION ON HEMOGLOBIN POLYMORPHISM IN THE ADULT PEKIN DUCK. Klein, J. Raymond (Brookhaven National Lab., Upton, N. Y.). Radiat. Res.; 46: 105-14(Apr 1971).

The rates of synthesis and concentrations in blood of the two hemoglobins found in adult duck erythrocytes were measured periodically during several months after x irradiation of the animal. Labeled glycine incorporation into the heme and globin components of the hemoglobins and labeled plasma iron incorporation into the heme components in blood in vitro were used to estimate the rates. The rates for both hemoglobins decreased during days 0 to 2 postirradiation and remained depressed until day 11. The depression in rate between days 7 to 11 was greater for the major than for the minor hemoglobin. Between days 11 to 25, the rates increased. The increase was less for the major than for the minor hemoglobin. After day 25, the rates returned to about the initial values. The changes in the rates were accompanied by roughly parallel changes in the blood reticulocyte level. The concentrations of the hemoglobins in blood decreased during days 5 to 15 and increased between days 15 to 30. The increase in concentration was less for the major than for the minor hemoglobin. Irradiation of blood in vitro did not affect the rates of synthesis of the hemoglobins. The findings were compatible with the possibility that irradiation of the animal represses the formation or function of the system directly involved in synthesis of the major hemoglobin as well as erythropoiesis. The findings were also compatible with another possibility, namely, that some erythrocytes contain only one of the hemoglobins and that the system giving rise to cells containing the major hemoglobin is more radiosensitive than the system giving rise to cells containing the minor hemoglobin. (auth)

32581 EFFECTS OF ACUTE BETA AND GAMMA RADIATION ON DEVELOPING EMBRYOS OF CARP (CYPRINUS CARPIO). Blaylock, B. G.; Griffith, N. A. (Oak Ridge National Lab., Tenn.). Radiat. Res.; 46: 99-104(Apr 1971).

The effects of acute β and γ radiation on developing Cyprinus carpio eggs were measured by the percentage of the eggs that hatched. Eggs were exposed to various doses of β and γ radiation from external sources thirty minutes after fertilization. LD_{50} doses established by a probit analysis were 500.5 rads for β and 601.3 rads for γ radiation. (auth)

32582 EFFECTS OF SIMULATED FALLOUT RADIATION ON IRON KINETICS, RED CELL MASS, AND PLASMA COPPER IN SHEEP. Wade, Leo Jr.; Sasser, L. B.; Bell, M. C. (UT-AEC Agricultural Lab., Oak Ridge, Tenn.). Contract AT(40-1)-GEN-242. Radiat. Res.; 46: 89-98(Apr 1971).

Iron kinetics, red cell mass, and plasma copper were measured in sheep subjected to various combinations of γ irradiation of the total body and β irradiation of the skin and gastrointestinal tract. Beta irradiation of the skin, and to a lesser extent of the gastrointestinal tract, produced hypoferremia, a decrease in circulating red cell mass, and hypercupremia. Changes in iron kinetics indicated an increased rate of erythropoiesis. It is suggested that the reduction in red cell mass is caused by an abnormally high rate of destruction of erythrocytes which are damaged as a consequence of circulating through injured tissue. The hypercupremia may be a response to the increased demand for iron necessary for hemoglobin formation. (auth)

32583 CHANGES IN THE ULTRASTRUCTURE OF THE DOG MYOCARDIUM AT DIFFERENT TIMES FOLLOWING WHOLE-BODY GAMMA IRRADIATION. Mityushin, V. M.; Bespalova, L. A. (Inst. of Biophysics, Moscow). Kardiologiya; 10: No. 6, 95-9(Jun 1970). (In Russian).

The ultrastructure of myocardial cells of the left ventricle was studied in dogs at different stages of acute radiation sickness

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caused by whole-body γ irradiation in a dose of 350 R. Electron microscopic investigation revealed a varying degree of sensitivity and injury susceptibility of myocardial intracellular structures. The most sensitive organelles were mitochondria in which destructive changes were noted during the first hours after γ irradiation. Myofibrils and muscle nuclei were the most resistant and injuries were observed only at late periods of the experiment. (auth)

32584 INTERFERENCE-MICROSCOPIC STUDY OF DRY WEIGHT AND WATER CONTENT IN BRONCHIAL EPITHELIAL CELLS IN RABBITS AFTER ^{60}Co GAMMA IRRADIATION. Nikulin, A.; Pikula, B.; Plamenac, P.; Djordjevic, J. (Medizinische Fakultaet, Sarajevo, Yugoslavia). Beitr. Pathol.; 142: 235-43(1971). (In German).

Changes in bronchial epithelium cells during the first ten days following local γ irradiation of rabbits were studied using quantitative interference-microscopic analysis. During the first 12 hr, the volume and water content increased both in the nuclei (61%) and the cytoplasm (23%) of the bronchial epithelium cells. After the third day there was a gradual loss of fluid, but the cells did not attain their original value until the tenth day. The dry weight in both the nuclei and cytoplasm increased during the same period. The increase in dry weight was less than the increase in volume and water content. The increase in volume and water content is explained on the basis of osmotic phenomena following changes caused by radiation in the cell membranes. The increase in dry weight of the cells is considered to be, in part, a consequence of extracellular protein penetration into the cell. The possibility of cellular damage caused by histamine liberation in the tissues at the moment of radiation was also considered. (E.E.H.)

32585 PATHOMORPHOLOGICAL CHANGES IN THE EYES OF IRRADIATED ANIMALS WITH CHEMICAL BURNS. Abdullaev, V. M. (Inst. of Roentgenology and Radiology, Baku). Azerb. Med. Zh.; 47: No. 6, 16-20(Jun 1970). (In Russian).

The results of four series of experiments on irradiation of the eyes in rabbits are reported. In the first series, 100 eyes in 55 rabbits were studied for morphological changes after a single exposure to radiation in a dose of 798 R for 42 min. Parabiomicroscopic and opthalmological studies indicated the presence of photophobia, lacrimation, hyperemia conjunctivitis of the eyelid and eyeball, and edema of the cornea. In some cases, infiltration and ulcer of the cornea were observed. In the second test series with 15 rabbits, the effects of chemical burns caused by 10 percent NH_4OH on the eye, were studied. Within the first minute after exposure to the chemical, hyperemia and conjunctivitis of the eyeball and eyelid were observed. Subsequently, the animals could hardly open the eyelids. After 1 to 2 weeks the symptoms subsided. In the third series of tests with 15 rabbits after irradiation of both eyes, one eye of each rabbit was treated with 10 percent ammonia solution to observe the combined effects of irradiation and the chemical. All symptoms were more pronounced in the eyes subjected to both treatments and recovery took place more slowly. In the fourth test series, both eyes of the test animal were irradiated and then treated with the chemical. Some of the animals perished. Pronounced changes took place in the eyes. However, these were not of equal magnitude in both eyes. Secondary infections, such as various inflammations, were observed. The recovery period began at the end of the fourth week and lasted through the sixth and seventh weeks. (JPRS)

32586 EFFECTS OF X IRRADIATION ON THE ACTIVITY OF ASPARTATE-AMINOTRANSFERASE IN BRAIN MITOCHONDRIA. Chernoguzov, V. M.; Pikulev, A. T. (Minsk State Univ.). Dokl. Akad. Nauk BSSR; 14: 367-9(Apr 1970). (In Russian).

It was established in white rats, that a single exposure to whole-body x irradiation at a dose of 40 R led to an increase in the activity of free aspartate-aminotransferase at the expense of a decrease in the activity of the bound form. The total activity of the mitochondrial enzyme was not altered by the irradiation. The changes observed are explained on the basis of structural alterations and changes in the physico-chemical properties of the mitochondria. (tr-auth)

32587 EFFECTS OF URANIUM ON THYROID FUNCTION AND ON THE DISTRIBUTION OF IODINE IN THE THYROID GLAND. Malenchenko, A. F. (Inst. of Nuclear Power Engineering, Moscow). Dokl. Akad. Nauk BSSR; 14: 376-8(Apr 1970). (In Russian).

In studies on rats during the first 2 days following administration of uranium nitrate, increased irregularity in iodine distribution in the thyroid gland, and signs of irradiation of the thyroidal parenchymal cells were detected. (tr-auth)

32588 ACTIVITY OF CERTAIN OXIDATION-REDUCTION ENZYMES IN THE LIVER OF HEALTHY RATS IN ORAL ADMINISTRATION OF RADON-CONTAINING WATER (HISTOCHEMICAL STUDY). Rekkandt, A. A.; Ryumshina, T. A.; Kozharskii, V. V. Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 35: 146-51 (Mar-Apr 1970). (In Russian).

Radon effects on the activity of certain oxidation-reduction enzymes in tissues of healthy rats were studied using white rats treated with natural radon water of the Pyatigorsk health resort stream (0.18 μCi/l) and artificially prepared waters with 3.64, 36.4, and 364 μCi/l. After 21 days of treatment, the activity of oxidation-reduction enzymes in the liver of rats increased in direct relation to the concentration of radon in the water and the absorbed radiation dose by the liver. (R.V.J.)

32589 REJOINING OF X-RADIOINDUCED STRAND BREAKS IN THE DNA OF A MURINE LYMPHOMA CELL (L5178Y). Ormerod, M. G.; Stevens, U. (Royal Cancer Hospital, Belmont, Eng.). Biochim. Biophys. Acta; 232: No. 1, 72-82(Feb 1971).

X irradiation introduces single-strand breaks into the DNA of cells. After irradiation, cells rejoin these strand breaks. In L5178Y cells, it was found that this process did not require DNA, RNA, or protein synthesis. Raising the temperature of postirradiation incubation from 37 to 43°, which did not influence the initial rate of rejoining, induced DNA degradation. Lowering the temperature to 20° or below inhibited strand-break rejoining. Irradiation of the cells in the presence of 30 mM cysteamine or cystamine did not influence the number of strand breaks observed. Postirradiation incubation of the cells at 37° in the presence of lower concentrations of these drugs induced DNA degradation. It was concluded that single-strand breaks in the DNA of a cell probably do not result in a lethal lesion. (auth)

32590 EFFECTS OF RADIATION INJURY ON SOME ABSORPTIVE AND METABOLIC PARAMETERS. D'Souza, D. W.; Thyagarajan, P.; Vakil, U. K.; Sreenivasan, A. (Bhabha Atomic Research Centre, Bombay). pp 231-51 of Macromolecules in Storage and Transfer of Biological Information. Bombay; Department of Atomic Energy (1970).

. From Symposium on macromolecules in storage and transfer of biological information; Bombay, India (15 Dec 1969). See CONF-691227.

Structural pathology resulting from exposure to ionizing radiation is preceded by metabolic alterations, the severity of which is a function of dose and nutritional status of the animal. Whole-body exposure of rats of x-irradiation impairs gastric secretion and composition with severe functional interference in protein digestion and in intestinal absorption of vitamin B_{12} and damage to the absorptive cells in the intestine. After 8 days, during subsequent repair processes, these derangements are corrected in animals irradiated at sublethal doses. Some of the glycolytic enzymes are of importance in the clinical evaluation of muscular damage. There is a progressive increase, up to 8 days post-irradiation, in total serum and tissue lactic dehydrogenase (LDH) and creatine phosphokinase (CPK) activities, which then decline to normal in 14 days. On electrophoretic resolution of heart LDH into the two main subunits LDH_H and LDH_M, a marked rise in M fraction is revealed, H remaining relatively constant. These and other results reported are interpreted to suggest that alterations in LDH isoenzyme distribution pattern and CPK activities could represent metabolic regulatory devices, besides serving as indices to cellular damage. (auth)

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Refer also to abstracts 32317, 32348, 32380, 32424, 32426, 32458, 32462, 32470, 32499, 32511–32513, and 32626.

32591 (CEA-CONF-1723) FORMATION OF DICENTRIC CHROMOSOMES IN HUMAN LYMPHOCYTES SUBJECTED IN VITRO TO A FLUX OF MIXED RADIATION (γ, NEUTRON). Biola, M. T.; Le Go, R.; Ducatez, G.; Dacher, J.; Bourguignon, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1970]. 16p. (In French). (CONF-701112-3). Dep. NTIS (U. S. Sales Only).

From Symposium on new developments in physical and biological radiation detectors; Vienna, Austria (23 Nov 1970).

Samples of human blood were exposed to various doses of mixed γ-neutron radiation and the leukocytes were transferred to culture media and observed microscopically for the development of chromosome aberrations. The findings were compared with those observed following the exposure of blood samples to a neutron beam or ^{60}Co γ radiation. A dose effect was observed for the cells exposed to the mixed γ-neutron

source. The possibility of using chromosome aberrations in cultured leukocytes as a biological dosimeter for man following exposure during criticality accidents is discussed. (C.H.)

32592 DISTANT HAZARDS OF THE TREATMENT OF HYPERTHYROIDISM WITH RADIOACTIVE IODINE. **Bricaire, H. (Faculte de Medecine, Paris. Hopital Cochin, Paris); Leprat, J. Therapeutique; 46: 9-12(Jan 1970). (In French).**

The long-term hazards of the use of ^{131}I are discussed under the aspects of the dangers inherent in the use of radioactivity (cancer, sterilization, and genetic damage) and of the delayed inducement of hypothyroidism. In the first group cancer is of concern only when ^{131}I is used for infants. Neither radioinduced cancer nor sterilization has occurred in adults as the result of its use. Data on genetic damage is insufficient for conclusions, but precautions should be taken for a person desiring and capable of procreation. The occurrence of progressive and persistent hypothyroidism one year or more after radiotherapy is discussed in detail. The symptomology, possible prevention, and treatment are also discussed. (J.S.R.)

32593 TOPICAL ACTION OF CORTISONE IN ASSOCIATION WITH CHLORAMPHENICOL IN THE TREATMENT OF RADIO-INDUCED LESIONS OF THE MUCOSA IN PATIENTS TREATED FOR CANCER OF THE ORAL CAVITY. **Pini, M. (Univ., Turin). Minerva Med. Giuliana; 9: 20-5(Jan-Feb 1969). (In Italian).**

In order to decrease the radioinduced injury to the healthy tissues in man surrounding a neoplastic lesion of the oral cavity, a drug containing cortisone in association with the antibiotic chloramphenicol should be used. The results obtained in the cases reported justify the use of this preparation. (tr-auth)

32594 CASTRATION RADIATION: RESULTS WITH SIMPLEST METHODS. DEDUCTIONS WITH REGARD TO CARCINOMA RADIATION. **Reinhardt, K. (Voelklingen/Saar District Hospital, Ger.). Strahlentherapie; 140: 378-84(Oct 1970). (In German).**

The simplest method showing the least source of mistakes for castration is irradiation by means of a standard incident dose to each ovary, from a ventral and a dorsal field. Theoretically, however, the application of a standard ovarian dose, or of an ovarian dose different to age and indications, appears to be more reasonable, but dosage results after a standard incident dose are of at least the same value. Since x-ray castration is possible with practically 100% security, independently from differentiated methods, it may be concluded that no significant progress in tumor therapy can be achieved through methodical improvements; neither is the speculation entirely unreasonable that tumor tissues might be induced, by means of chemical compounds of ovocytes, to manifest the radiosensitivity of egg cells. (auth)

32595 DEVELOPMENT OF A POST-CRICOID CARCINOMA FOLLOWING MULTIPLE X-IRRADIATION OF THE NECK REGION FOR TUBERCULOSIS LYMPH NODES. **Heilmann, Hans-Peter (Univ., Tuebingen, Ger.). Strahlentherapie; 140: 388-91 (Oct 1970). (In German).**

A post-cricoid carcinoma that was manifested about 50 years after multiple irradiation (x rays) of the neck region for lymph node tuberculosis is reported. It was possible to regain from the irradiation documents, partially still at disposal, the details of the irradiations carried out in 1920. (auth)

32596 REACTIONS OF SKIN TO THERAPY WITH ACCELERTOR ELECTRONS OF VARIABLE ENERGY FROM 5 TO 42 MeV. **Maestro, A.; Squassabia, A.; Casolo, F.; Zanolla, W. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 229-46(Nov 1968). (In Italian).**

The characteristics and the evolution of the skin reactions induced by betatron-accelerated electrons with energy from 5 to 42 MeV are summarized. The factors affecting the reactions, both biological and those dependent on the irradiation scheme and particularly those connected with the characteristics of the apparatus used, are evaluated. It was concluded that the skin reactions, although less intense than those induced by traditional x-ray therapy, should be evaluated attentively in order to avoid pronounced early and delayed lesions. (tr-auth)

32597 REACTION OF THE MUCOSA OF THE ORAL CAVITY IN THE COURSE OF RADIOTHERAPY WITH ACCELERATOR ELECTRONS. **Maestro, A.; Squassabia, A.; Casolo, F. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 247-53 (Nov 1968). (In Italian).**

The characteristics and the evolution of the reactions of the mucosa of the oral cavity of patients exposed to radiotherapy with high-energy electrons from a betatron are summarized. (tr-auth)

32598 ALTERATIONS IN THE PULMONARY PLEURA OF PATIENTS IRRADIATED WITH 42 MeV BETATRON FOR BRONCHOPULMONARY TUMORS. **Coucourde, F.; Garbagna, P.; Piazza, G.; Nicolato, A. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 255-74(Nov 1968). (In Italian).**

The clinical, radiological, and bronchological aspects of the pleuro-pulmonary reactions induced in patients irradiated for pulmonary neoplasia with photons and electrons from a 42-MeV betatron are described. On the basis of the observations made, it was concluded that the pulmonary fibroses from 42-MeV photons and electrons are not so detached, as a rule, as those observed with radiations of other energies. The importance of bronchological investigations and particularly of the bronchography for a correct differential diagnosis with the neoplastic relapses is stressed. (tr-auth)

32599 BRONCHOSCOPIC DISCOVERIES IN PATIENTS AFFECTED WITH BRONCHOPULMONARY NEOPLASMS IRRADIATED WITH 42 MeV BETATRON. **Coucourde, F.; Piazza, G.; Garbagna, P.; Casolo, F.; Schifino, A. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 275-92(Nov 1968). (In Italian).**

The bronchoscopic pictures observed after irradiation with a 42-MeV betatron of 85 patients affected with central bronchopulmonary neoplasms are described. On the basis of the observations made, the importance of bronchoscopic examinations in order to evaluate the radiation effects and the results of radiotherapy was confirmed. (tr-auth)

32600 BASIC RESEARCH ON MODIFICATIONS OF BLOOD COAGULATION IN PATIENTS IRRADIATED WITH ^{60}Co. **Biscarini, R. Radiaz. Alta Energ.; 7: Suppl. No. 4, 305-14(Nov 1968). (In Italian).**

The arguments on the effect on the blood of radiation administered for therapeutic purposes to patients with neoplasms are reviewed. The conclusions were that there is only minimum hematological modifications as a result of radiotherapy on neoplastic patients, although the attention of the radiologist to the hematological control of all patients is justified. In particular, it is noted that radiation can, in proportion to the dose administered, cause a state of hypocoagulation, although at the beginning of the treatment some degree of hypercoagulation may be present. In recent years, experimental studies on neoplastic patients on the effects of ^{60}Co γ radiation have shown that in addition to the usual moderate state of hypocoagulation at usual therapeutic doses there is, at the end of the treatment, some degree of hypercoagulation in patients irradiated on the thorax, perhaps in proportion to the radioinduced release of thromboplastin, which is abundant in pulmonary tissue. (tr-auth)

32601 HEMOCOAGULATIVE MODIFICATIONS IN PATIENTS IRRADIATED WITH 42 MeV BETATRON FOR PULMONARY NEOPLASMS. **Pasotti, C.; Spreafico, P. L.; Garbagna, P.; Michelotto, U. (Univ., Pavia, Italy). Radiaz. Alta Energ.; 7: Suppl. No. 4, 315-22(Nov 1968). (In Italian).**

In a group of 16 patients with malignant pulmonary neoplasia, 6 patients were treated with photons and 10 with electrons from a 42-MeV betatron. The evaluation of various hemocoagulative tests (prothrombin activity, recalcification time, thromboelastogram, VIII factor, platelet and platelet aggregation content) showed that only the decrease of the platelets in the group treated with photons was statistically significant, and the modification of all the other parameters in the two groups was not statistically significant. (tr-auth)

32602 RADIATION DEPENDENT CHANGES IN LUNG AND PLEURA FOLLOWING TANGENTIAL ^{60}Co PENDULUM IRRADIATION OF MAMMARY CARCINOMAS. RESULTS ON ROENTGENOLOGICAL AND LUNG-FUNCTION ANALYSIS INVESTIGATIONS. **Fischer, J.; Muysers, K.; Smidt, U.; Thiemann, Kl. J.; Worth, G. (Johanniter-Krankenhauses, Rheinhausen, Ger. Krankenhauses Bethanien, Moers, Ger.). Strahlentherapie; 140: 478-85(Nov 1970). (In German).**

Clinical and roentgenological thorax examinations were made in 110 cases (female patients), who were treated for mammary carcinoma with a tangential ^{60}Co pendulum irradiation of the chest wall; these examinations were carried out before and after radiotherapy. At the same time, functional lung analyses were made in 59 of the patients. No indications of acute (radiation pneumonia) or a chronic (lung fibrosis) lesion of the lung parenchyma were noted. (auth)

32603 RADIATION BURDEN TO BONE MARROW IN RADIOTHERAPY OF NON-BLASTOMATOUS DISEASES OF THE SPINAL COLUMN. **Hrabovszky, Zoltan; Nikl, Istvan (Frederic-Joliot-Curie-Forschungsinstitut fuer Strahlenbiologie und Strahlenhy-**

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giene, Budapest). Strahlentherapie: 140: 515-18(Nov 1970). (In German).

Measurements and calculations were made with regard to bone marrow and joint doses during x irradiation of the spinal column for non-blastomatous diseases. Three different qualities of rays were used. It was stated that an irradiation of 85 kV (at a total filtration of 5 mm Al) affected the bone-marrow 50% less than that of 180 kV and at a total filtration of 0.5 mm Cu. In measurements, there was an identical therapeutic effect on the joints. Low dose irradiation is recommended as result of the clinical experiences. (auth)

32604 CONSTRICTIVE PERICARDITIS AND RADIOTHERAPEUTIC MYOCARDITIS ARISING IN THE LONG-TERM AFTER-EFFECTS OF MEDIASTINAL HODGKIN'S DISEASE TREATED BY SURGICAL EXCISION AND MASSIVE IRRADIATION. Dureau, G.; Teneriello, F.; Chassignolle, J.; (and others) (Univ., Lyon). Lyon Chir.; 66: 376-9(Sep-Oct 1970). (In French).

The observation described concerns Hodgkin's disease and illustrates in a general way the heart complications ascribable to mediastinal radiotherapy. The cases published show that a 4000 rad dose seems sufficient to cause constrictive pericarditis; the clinical expression of the liquidian phase is generally not very severe; associated lesions of the myocardium may arise, but generally pericardectomy gives satisfactory results. (France)

32605 AGING IN HIROSHIMA AND NAGASAKI ATOMIC BOMB SURVIVORS: ACCUMULATION OF CARDIAC LIPOFUSCIN. Anderson, Robert E.; Yamamoto, Tsutomu; Oshida, Kenzo; Thorslund, Todd. J. Amer. Geriat. Soc.; 19: 193-8(Mar 1971).

A report is given of the amount of age-dependent lipofuscin in the myocardium (left ventricle) as found at autopsy in a group of 54 persons that had been exposed proximally (1,400 meters from the hypocenter) to the Hiroshima and Nagasaki atomic bombs of 1945. The subjects were matched by sex and age-decade of death with a similar number of subjects who were in neither city at the time of the explosions. The results failed to demonstrate an accelerated accumulation of pigment in the proximally exposed group. Although the difference was not statistically significant, the majority of the exposed group appeared to accumulate lipofuscin more slowly than did the non-exposed group. The possible implications are discussed. (auth)

32606 CAUSE OF RADIORESISTANCE IN RETINOBLASTOMA: PHOTORECEPTOR DIFFERENTIATION. Ts'o, Mark O.; Zimmerman, Lorenz E.; Fine, Ben S.; Ellsworth, Robert M. (George Washington Univ., Washington, D. C.). Trans. Amer. Acad. Ophthalmol. Oto-Laryngol.; 74: 959-69(Sep-Oct 1970).

Forty-two eyes in which there were residual retinoblastomas following radiotherapy were examined histopathologically. Forty percent of the tumors showed areas of photoreceptor differentiation. Three histopathologic patterns were noted. Some tumor nodules consisted entirely of cells showing photoreceptor differentiation while other tumor nodules consisted of cells mingled with glial cells or undifferentiated retinoblastoma cells. Detailed clinical descriptions before and after radiotherapy were available on four of the tumor nodules. These tumor nodules were described as grayish, translucent, or fish flesh in appearance. In the follow up of 13 patients, only one tumor death was recorded. It is suggested that, while the tumors with photoreceptor differentiation are relatively benign histopathologically, they are comparatively resistant to radiotherapy. (auth)

32607 BLOOD COAGULATION CHANGES CAUSED BY DIAGNOSTIC AND THERAPEUTIC DOSAGE OF ^{131}I. Nenci, G. G.; Casamassima, F.; Notaristefano, A. (Univ., Perugia, Italy). Riv. Patol. Clin. Sper.; 10: 107-12(Apr-Jun 1969). (In Italian).

In 14 hyperthyroid patients treated with a therapeutic dose of radioactive iodine (5mCi), a blood coagulation follow-up was carried out. A slight reduction of platelet level was found. Other minor abnormalities, that probably were due to an initial intravascular activation of the clotting system, are outlined. The patients also had an increased F.VIII activity, which tended to normalization after the therapy. (auth)

32608 STATE OF THE COAGULATION AND ANTICOAGULATION BLOOD SYSTEM IN RADIATION TREATMENT OF PULMONARY CANCER. Strashinin, A. I.; Evdokimov, N. M.; Zlydnikov, D. M. (Central Research Roentgeno-Radiological Inst., Leningrad). Vop. Onkol.; 17: No. 1, 78-9(1971). (In Russian).

The state of blood coagulation and anti coagulation systems during local radiotherapy for lung tumor was studied with 39 patients. Hemostasis indexes were determined during local tumor dose accumulations of 1500, 3000, 4500, and 5000 rad. Trombosis observed in the patients with lung tumors obviously was induced by the amplified blood coagulation and weakened protective mechanisms of the anticoagulation blood system. Hypercoagulation disappeared following successful radiotherapy and the coagulation and anticoagulation indexes returned to normal. (R.V.J.)

32609 MANAGEMENT OF RADIATION-INDUCED VAGINAL FISTULAS. Boronow, Richard C. (Univ. of Mississippi, Jackson). Amer. J. Obstet. Gynecol.; 110: No. 1, 1-8(1 May 1971).

Ten sizable radioinduced vaginal fistulas were closed utilizing a pedicle swung from the labial fat pad to provide supportive bulk and new blood supply to the suture line. Eight of these 10 were primarily successful. The results have encouraged further utilization of this technique in these difficult fistulas. Frustration and abandonment are not justified until all efforts have been expended. In the majority of instances, these patients will be rewarded with successful rehabilitation. (auth)

32610 X-RAYS, THEIR DYNAMICS AND HANDLING. Fitzgerald, Gordon M. ADM (Rev. Asoc. Dent. Mex.); 26: 133-43 (Mar-Apr 1969). (In Spanish).

The pathological effects of various doses and energy levels of x radiation on man are reviewed. The hazards to patients and medical personnel during the use of x radiation for diagnostic and dental radiography and for therapy are discussed. (TSS)

32611 OCCUPATIONAL RADIODERMATITIS IN PHYSICIANS. De Dulanto, F.; Castilla-Pertinez, R. (Univ., Granada, Spain). Actas. Dermo-Sifiliogr.; 59: 369-78(May-Jun 1968). (In Spanish).

The hazards to physicians using radiation without proper protection are reviewed. It is pointed out that the maximum permissible radiation dose for skin surface is 60 rem/yr. A mild case of radiodermatitis responds to treatment with cortisone and vitamin A ointment, but deep ketatomas must be removed, preferably by electrocoagulation. Severe radiation injuries and chronic radiodermatitis may become malignant. Data are summarized on a limited number of physicians who developed malignancies from one to eighteen years following radiation exposures. The cases are analyzed as to radiation dose, energy level, age at exposure, circumstances of the exposure, and time over which the exposure was received. Seven cases of malignancies in physicians, including three pediatrists, two surgeons, one internist, and one radiologist, who had used radiation sources or radioisotopes for therapy or diagnosis are discussed in detail. (TSS)

32612 POSTRADIATION SARCOMA OF THE SOFT TISSUES. Daniel-Bek, K. V.; Yagunova, L. V.; Rabinovich, E. A. (Moscow Research Inst. of Oncology). Med. Radiol.; 16: No. 3, 20-4 (Mar 1971). (In Russian).

Observations were made on patients subjected to radiation treatment for malignant tumors in whom sarcoma developed in the zone of radiation injuries of the tissues after a prolonged interval of 10 to 23 years. On one patient after radiation treatment of bronchogenic cancer, against the background of radiation ulcer, there was seen a simultaneous development of spindle-cell sarcoma and planocellular cancer with a predisposition to cornification. Sarcoma may also develop in zones subjected to irradiation that do not reveal trophic changes. (auth)

32613 DEFICIENT DNA SYNTHESIS AND MITOTIC DEATH IN X-IRRADIATED HeLa CELLS. Hopwood, L. E.; Tolmach, L. J. (Washington Univ., St. Louis). Radiat. Res.; 46: 70-84 (Apr 1971).

DNA synthesis was measured in the generation (Generation 1) following the one in which synchronous HeLa S3 cells were irradiated during G1 with 220 kV x rays. The rate of thymidine incorporation throughout the S phase was reduced in a dose-dependent fashion such that about $\frac{2}{3}$ of the normal amount was incorporated after a dose of 500 rads. Chemical determination of the DNA content in G1 and G2 of Generation 1 confirmed that the incorporation values are valid measures of DNA synthesis. Autoradiographic analysis showed that most of the cells synthesize a reduced amount of DNA, but the reduction was much greater in some cells than in others. It was found previously that virtually the entire cell population completes Generation 1, but about 25% of the cells are permanently arrested in mitosis at the end of that generation. The arrested cells were separated from dividing cells and examined for the amount of DNA they had synthesized in Generation 1. On the average, only about 30% of the normal amount was replicated in those cells. The dividing cells, in contrast, replicated on the average about 80% of the normal amount. It is postulated that severely deficient DNA synthesis is closely related to permanent mitotic arrest. (auth)

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32614 CAPILLARY MICROSCOPIC OBSERVATION ON THE SUPERFICIAL MINUTE VESSELS OF ATOMIC BOMB SURVIVORS, 1956–1957. Tsuya, Akira; Wakano, Yoichi; Otake, Masanori (Cancer Inst. Hospital, Tokyo). Radiat. Res.; 46: 199-216(Apr 1971).

Capillary morphological studies were conducted during 1956 and 1957 at the Atomic Bomb Casualty Commission (ABCC) on superficial blood vessels to determine late somatic effects of irradiation on 435 subjects composed of A-bomb survivors of Hiroshima and their controls. Significant differences were observed in the score assigned to morphological changes in the proximally exposed group and those exposed to 100 rad or more under the age of 10 at the time of the bomb. The level of significance was higher for labial and lingual mucosa than fingernail fold and bulbar conjunctiva. (auth)

32615 X-RAY DIFFRACTION INVESTIGATION ON THE EFFECT OF EXPERIMENTAL AND IN SITU RADIATION ON MATURE HUMAN TEETH. A PRELIMINARY REPORT. Jervoee, Peter (Technical Univ. of Denmark, Lundtofte. Univ. of Copenhagen). Acta Odontol. Scand.; 28: 623-31(Nov 1970).

X ray diffraction investigation demonstrated that experimental radiation with 1 M-rad ^{60}Co γ, with single or cumulative doses, of mature human teeth as well as in situ radiation with 12,000 R induces changes in the crystalline structure of human enamel and dentine. The experimental radiation of dentine required much greater dose to obtain the same crystalline change as the in situ irradiated molar dentine. The radioinduced crystallographic changes must be considered in addition to the changes caused by hyposalivation in the microphysiological and microbiological oral milieu. (auth)

Radiation Effects on Plants

Refer also to abstracts 32353, 32355, 32363, 32381, 32385, 32386, and 32631.

32616 (AECL–3678) CHECK LIST REVISIONS OF THE PLANTS OF THE WHITESHELL AREA, MANITOBA, INCLUDING A SUMMARY OF THEIR PUBLISHED RADIATION SENSITIVITIES. Dugle, Janet R.; El-Lakany, M. H. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Jan 1971. 31p. Dep. NTIS (U. S. Sales Only). AFCL $1.00.

Eighty-three revisions and additions to the check list of the vascular plants of the Whiteshell area of Manitoba, Canada, are included. Radiation sensitivity data are given for 30 of the vascular plant taxa collected at Manitoba and for a further 45 taxa not collected at Manitoba but in families or genera included in the collection. (auth)

32617 EFFECTS OF RADIOINDUCED ELECTROLYTE CHANGES ON METABOLISM. III. IMPORTANCE OF ION MEDIUM ON MANIFESTATION OF RADIATION LESIONS IN YEAST. Rink, Hermann (Univ., Bonn). Strahlentherapie; 140: 594-9(Nov 1970). (In German).

The intracellular electrolyte concentration was measured in baker's yeast after a 5 hr acetate respiration in a milieu containing different concentrations of K^+ and Na^+ ions and with restriction of endogenous substances. The influence of irradiation, as measured by the increased Na^+ and the decreased K^+ ions, was strongly influenced by the concentration and composition of the medium. The measured respiration rates allow the conclusion that there is no primary lesion in energy metabolism, but that there are secondary influences of the medium on enzymes depending on K^+ and Na^+. The primary lesion is probably a modification of the cellular membrane or surface, probably an oxidation of SH-groups. (auth)

32618 RETARDATION OF ULTRAVIOLET LIGHT ACCELERATED LEAF SENESCENCE BY A CYTOKININ: N^6 BENZYLADENINE. Wu, J. H. (California State Polytechnic Coll., Pomona). Photochem. Photobiol.; 13: 179-81(Feb 1971).

One half of leaves of Nicotiana glutinosa were exposed to ultraviolet radiation for four minutes (9360 ergs/mm^2). A few minutes after exposure, two drops of aqueous solution (50 ppm) of ^{6}N benzyladenine (BA) were put on each half leaf. Four days after dark incubation at 28°C, the BA treated area remained green, the rest becoming chlorotic. In the unirradiated leaves, the younger kept their color longer. Cross sections of leaf tissue with uv induced chlorosis, (4–6 mins radiation), showed that palisade and spongy mesophyll cells were chlorotic, but in the BA treated areas, chloroplasts disappeared in BA and non-BA treated irradiated upper epidermis, indicating that BA could not repair or retard damage in cells directly absorbing radiation. BA retarded chlorosis when applied as long as 48 hrs after irradiation. BA did not prevent glazing in leaves grown in shade and exposed to uv radiation for 2 minutes. (UK)

32619 EFFECT OF THE STORAGE TEMPERATURE OF IRRADIATED SEEDS ON FREQUENCY OF CHROMOSOME ABERRATIONS. Pomogaibo, V. M. (Inst. of Microbiology and Virology, Kiev). Tsitol. Genet.; 4: 275-7(May-Jun 1970). (In Russian).

The preserving effects of lower temperature (–3°C) on the development of radiation damages were found during long storage of irradiated winter rye seeds. The data obtained are in agreement with the results of analogous experiments with irradiated animals. (auth)

32620 EFFECTS OF FAST NEUTRONS ON THE GROWTH OF CARROT ROOT PHLOEM EXPLANTS. Gollnick, Daniel A.; Caplin, Samuel M. (California State Coll., Los Angeles). Radiat. Res.: 45: 557-62(Mar 1971).

Carrot root phloem tissue explants were irradiated with 14-MeV neutrons, the dose delivered determined from the induced radioactivity of the glass sample tube. The irradiated explants were grown aseptically on a culture medium that allowed rapid growth. A 50% production in fresh weight in 14 days was produced by a fast neutron dose of 840 rads. This was due to a reduced growth rate maintained during the growth period. (auth)

32621 EFFECTS OF GROWTH STIMULANTS ON THE PRODUCTIVITY OF IRRADIATED POTATO TUBERS OF THE VARIETY LORKH. Serebrenikov, V. S.; Nikolaeva, A. P. Khim. Sel. Khoz.; No. 10, 51-2(1969). (In Russian).

The irradiation of potatoes at a dose of 2000 R led to a reduction, in the contents of starch and ascorbic acid, in the tubers. The results were apparently related to the lower physiological maturity of the tubers and to the reduced transport of cyclic materials from the leaves to the tubers. Treatment with gibberellins, heteroauxins, and succinic acid increased the quantity of starch up to the level of the controls and, to a lesser degree, increased the content of ascorbic acid. Following treatment with the growth stimulants, tubers that were irradiated at a dose of 300 R produced a higher quality of potato. (tr-auth)

32622 REPAIR OF ULTRAVIOLET RADIATION DAMAGE BY THIOUREA. Bhuttacharya, K. K.; Nandi, P.; Mishra, A. K. (Bose Inst., Calcutta). pp 275-9 of Macromolecules in Storage and Transfer of Biological Information. Bombay: Department of Atomic Energy (1970).

From Symposium on macromolecules in storage and transfer of biological information; Bombay, India (15 Dec 1969). See CONF-691227.

The major photo-chemical lesions by far uv are due to the dimerization of pyrimidines in the DNA strands, which lead to mutation and killing of the microorganisms. These damages can be modified by various physical and chemical agents. Thiourea was found to behave as a chemical modifier, which gave protection as well as recovery from the damaging effects of uv radiations in Aspergillus terreus, thereby showing that it can save the target macromolecules from deleterious effects of uv. A high DMF (Dose Modifying Factor) value was actually observed when conidia during uv irradiation were suspended in 0.1M soln. of thiourea as well as when conidia were irradiated with uv which had been harvested from medium containing 0.008M of thiourea as the major N_2 source. The induction of mutation was also reduced when 0.1M soln. of the chemical was used during irradiation. This chemical, at the concentration tried, has nothing to do with the viability of conidia in any way. (auth)

32623 EFFECT OF ^{32}P IRRADIATION ON FREE CELLS AND CELL GROUPS OF GRAPE PHYLLOXERA GALL AND NORMAL STEM IN MICROCULTURE. Arya, H. C. (Univ. of Rajasthan, Jaipur, India). pp 317-20 of Macromolecules in Storage and Transfer of Biological Information. Bombay: Department of Atomic Energy (1970).

From Symposium on macromolecules in storage and transfer of biological information; Bombay, India (15 Dec 1969). See CONF-691227.

Cells from cultures of grape Phylloxera induced galls and normal stems were exposed to various intensities of beta-rays from ^{32}P. Observations were recorded of the responses of such cells in microcultures. Two fast-growing clones, one normal G S6-24 and another gall, GP4-21, were selected for the investigation. The tissues were grown on the agar c-medium and 24 hr before irradiation calli were transferred to liquid c-medium on shakers. The required amounts of ^{32}P were incorporated in the culture for

obtaining various intensities of irradiation in rads of 200, 100, 50, 25, and 10. Immediately after irradiation microcultures were made containing approximately 100 cells occurring free or in small groups. The high doses of 100 R, 200 R stopped cytoplasmic movements of normal and gall cells within 24 hr. The gall cells were relatively more sensitive than normal cells. The organelles visibly affected by irradiation were mitochondria, spherosomes, and nucleus. Both types of cells survived and low doses of 25 R and 10 R. The normal cells formed large colonies. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 32355, 32367, 32386, 32454, 32456, 32459, 32632, and 34079.

32624 (COO-1683-34) MECHANISM OF REGULATION AND CATALYSIS. Technical Progress Report, December 1, 1969–November 30, 1970. Gunsalus, I. C. (Illinois Univ., Urbana. Dept. of Biochemistry). Contract AT(11-1)-1683. 5p. Dep. NTIS.

Studies were continued on the effects of ultraviolet radiation on transfer of extrachromosomal genes among bacterial strains and species. The fluorescent bacteria, Pseudomonas putida, P. aeruginosa, and P. fluorescens were used in studies on the conjugation system. Transfer of plasmids and of chromosomal borne gene clusters was demonstrated. Experiments on the genetic control of isobutyric acid metabolism were carried out. Additional experiments were carried out on protein interaction using a two-component biosynthetic enzyme system. Results of the experiments are significant in elucidating the processes of transfer and regulation of extrachromosomal elements and may provide a model for studies on mammalian systems. It is suggested that results of these studies are related to processes that might influence living organisms through increased levels of irradiation and pollution in the environment. (H.L.W.)

32625 FACTORS AFFECTING THE RADIATION RESISTANCE OF DRIED BACTERIAL SPORES. Shoesmith, J. G. (Leeds Univ., Eng.). Guy's Hosp. Rep.; 119: 185-94(1970).

It was found that survival curves of γ-irradiated dried bacterial spores sometimes show the existence of a proportion of spores three to five times more resistant than the majority. Gelatin, serum, and dextran could increase the resistance of dried spores by up to 2.6 times and the resistance of both normal and gelatin-protected spores was found to be modified by variations in moisture content over the range 4 to 99% relative humidity. (auth)

32626 INFLUENCE OF RADIATION TREATMENT ON THE MICROFLORA OF THE SKIN AND INTESTINE IN PATIENTS WITH CANCER OF THE RECTUM. Kochetkova, V. A.; Golubeva, I. M.; Simakina, E. P.; Smirnova, E. S.; Khrushchov, M. M. (Moscow Research Inst. of Oncology. Central Inst. for Graduate Work in Medicine, Moscow). Med. Radiol.; 16: No. 3, 15-20 (Mar 1971). (In Russian).

The results of bacteriological examination of 65 patients suffering from cancer of the rectum are described. A correlation between the character of the microflora and the spread of the process was found. In the second stage of the disease, manifestations of intestinal dysbacteriosis were noted in 22%, in the third stage, in 37.5%, and in the fourth stage, in 66.6% of the cases. Preoperative radiation treatment conducted in 25 patients with cancer of the rectum in a total focal dose of 2000 to 25,000 rad using fractionated doses of 470 to 500 rad which is accompanied by a reduction of the defense mechanisms of the organism resulted in an increase in the number of pathogenic and drug-resistant forms of microorganisms. These changes in the intestinal autoflora should be taken into consideration during the preoperative preparation of patients and in the treatment of postoperative complications. (auth)

32627 ABILITY OF SALMONELLA TYPHIMURIUM TO REJOIN X-RAY INDUCED SINGLE STRAND BREAKS IN THE DNA. Hudnik-Plevnik, T. A.; Djordjevic, N. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). Stud. Biophys.; 20: 17-22(28 Feb 1970).

Studies were made on the radiosensitivity of Salmonella typhimurium LT-2 by analyzing the bacterial DNA prelabelled with radioactive thymidine from the irradiated and unirradiated S. typhimurium in the alkaline sucrose density gradient. During postirradiation incubation, a significant increase in the sedimentation velocity of the DNA took place. However, in S. typhimurium this process was much slower than in Escherichia coli B/r after the same dose of x rays. Although there was some rejoining of x ray induced breaks in the DNA of S. typhimurium, it was not efficient to make a complete repair. (auth)

32628 EFFECT OF CHLORAMPHENICOL ON SURVIVAL OF ULTRA-VIOLET-IRRADIATED CELLS OF ESCHERICHIA COLI B_{s-1}. Morozov, I. I.; Myasnik, M. N. (Inst. of Medical Radiology, Obninsk, USSR). Stud. Biophys.; 20: 43-50(28 Feb 1970).

Experiments were conducted to verify the assumption that conditions favoring the survival of Escherichia coli B will also affect the survival of E. coli B_{s-1} since they both contain gene fil^+, which determines the formation of elongated filament cells. Escherichia coli B_{s-1} were uv irradiated on a media containing different concentrations of chloramphenicol, and the surviving fraction was determined. The results showed that survival of E. coli B_{s-1} depends upon the post-irradiation conditions of the culture. (E.E.H.)

32629 EFFECT OF CHLORAMPHENICOL TREATMENT IN THE POST-IRRADIATION PERIOD ON SURVIVAL OF ESCHERICHIA COLI B_{s-1} IRRADIATED BY γ RAYS AND α PARTICLES. Morozov, I. I.; Myasnik, M. N. (Inst. of Medical Radiology, Obninsk, USSR). Stud. Biophys.; 20: 51-8(28 Feb 1970).

Studies were made on the survival of E. coli B_{s-1} depending on the conditions of the culture, i.e. treatment with chloramphenicol, after α irradiation and after γ irradiation. The results showed that chloramphenicol treatment led to an increase in survival following γ irradiation. After α radiation, chloramphenicol did not effect the survival of the cells. The reduction in sensitivity of E. coli B_{s-1} after α radiation seemed paradoxical and contradicted the current concepts concerning the effects of this type of radiation on the cells. (E.E.H.)

32630 INFECTIOUS DNA FROM COLIPHAGE T1. II. HOST-CELL REACTIVATION OF UV-IRRADIATED MOLECULES. Hotz, G.; Mauser, R. (Kernforschungszentrum, Karlsruhe, Ger.). Mol. Gen. Genet.; 108: 233-42(16 Oct 1970).

Infectious DNA from phage T1 was inactivated by uv-light (2,537 Å). No effect of irradiation on the kinetics of the assay in a spheroplast system could be observed. Uv-damaged molecules compete with unirradiated DNA for the infection. Infectious T1-DNA is subject to host-cell reactivation of uv-damage, the amount of which depends on the physiological conditions of the spheroplasts. Though uv-radiosensitivity of T1 particles is not influenced by the presence of the radical scavenging compound cysteamine, infectious DNA can be protected effectively by this chemical (0.01 M) against uv-damage when HCR-negative spheroplasts are used for the assay. Incorporation of 5-bromouracil radiosensitizes infectious T1-DNA in the presence and absence of HCR. This effect can be eliminated when the DNA is irradiated in the presence of cysteamine. The mechanism of radioprotection is discussed. (auth)

Radiosterilization and Radiopreservation

32631 (AECL-3855) RECOVERY AND BENEFITS FROM RADIATION DAMAGE. Lewis, W. Bennett (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Mar 1971. 19p. Dep. NTIS (U. S. Sales Only). AECL $0.50.

A new radiation science has been developing which indicates a growing recognition of the phenomenon of recovery from radiation damage, specifically the close interaction of radiation with thermal and chemical processes. There are many areas of research, and already some applications, in which radiation damage is employed in order to enjoy the benefits of recovery. Examples are the strengthening of polymers by radiation-induced cross-linking, disinfestation and extension of the shelf-life of foods, improvement of plant growth by seed irradiation, and the production of useful plant mutations. (auth) (TSS)

32632 (IAEA-R-442) THE COMBINED EFFECTS OF IONIZING RADIATIONS AND WATER ACTIVITY ON OSMOPHILIC YEASTS, WITH SPECIAL REFERENCE TO THE RADIATION PRESERVATION OF FRUIT JUICES IN COMBINATION WITH FREEZING CONCENTRATION. Kiss, J.; Farkas, J. (International Atomic Energy, Vienna (Austria)). 1969. 15p. NTIS (U. S. Sales Only).

Keeping quality of concentrates prepared by cryoconcentration may be increased by radiation treatment. Storage stability of concentrates of 0.90 to 0.94 water activity and treated with 0.8 Mrad gamma radiation increased 15 to 20 fold when a spoilage level of 5% was chosen as the criterion of spoilage. During cryoconcentration, a darkening of the juice occurs which increases on storage. Irradiation has a clarifying effect already at 0.3 Mrad, particularly effective at 55°C for grape juice. The temperature applied during pectolytic clarification following juice extraction

depends on the optimum temperature of the activity of the enzyme preparation used. For apple, strawberry and grape juice, 55°C proved satisfactory. No change of taste occurs below a water activity of 0.96, except in grape juice which disappeared again within a few days of irradiation. The LD 90 value for some yeasts in apple juice on irradiation was between 0.035 and 0.115 Mrad. The combined effect of fructose concentration and irradiation caused the proportionate reduction in yeast growth rate, except for Zygosaccharomyces nadsonii. The radiation resistance of osmo-resistant strains is not affected by the reduction of water activity, but that of osmo-sensitive strains is. Radiation treatment reduces the inhibitory concentration of osmo-tolerant yeasts. The dehydrogenase activity of the strains considered osmo-tolerant is lower than that of the osmo-sensitive strains. The grape juice concentrate and the nutrient prepared with fructose or glucose, irradiated in the solid state, extended the lag phase of growth of Saccharomyces cerevisiae var. ellipsoideus T_{22}, while saccharose did not. The logarithmic phase of growth was not affected. Local fruits were harvested and exposed to doses that could be tolerated by the fruits. Mature green and greenish yellow maturities were used for bananas and mangoes. They were stored at controlled temperatures and analyzed regularly during storage. Ascorbic acid content was not adversely affected by low-dose irradiation. Starch content was found higher while sugar content was lower in treated bananas, which could be correlated with the delay in ripening in the irradiated samples. Mangoes exhibited a higher sugar content, which explains the sweeter taste found by the taste panel, while carotene content was not affected significantly. Total plate counts were taken to determine the initial fungal population and results showed counts of irradiated fruits were significantly lower than the controls. Inoculations with known number of spores before and after irradiation showed that treated fruits developed smaller areas of infection than the control fruits. Exposure of spore suspensions of anthracnose for both mango and banana produced reduction of germination with increasing dose of radiation and complete inhibition at 400 kr. (auth)

32633 POTATOES, ONIONS, AND WHEAT. Int. At. Energy Agency Bull.; 13: No. 1, 20-5(1971).

The testing of irradiated foods with special reference to wheat, potatoes, and onions for wholesomeness was carried out in several countries. A chart of irradiated food products cleared for human consumption in different countries is given, showing the dose and source of radiation (cobalt-60, electrons, and cesium-137) used. (F.M.M.)

32634 IRRADIATION PRESERVATION OF FOODS. PART I. PROLONGATION OF THE KEEPING QUALITY OF FRESH FISH BY RADIATION PASTEURIZATION. Linko, R. R. (Huhtamaeki-yhtymae Oy, Turku, Finland). Maataloustieteelinen Aikak.; 42: 254-61(1970).

The prolonging of refrigeration shelf life (at 0°C) of pike and saithe was studied by radiation pasteurizing the fish with cobalt-60 gamma rays. The fish were packed whole in polyethylene bags. The radiation doses varied for pike between 150 to 1200 krad and for saithe between 150 to 250 krad. Organoleptic evaluations showed burnt off-flavor and off-odor in irradiated pike, which in fish that had been subject to small doses of 150 and 250 krad disappeared only after about one week of storing under refrigeration. For saithe no off-flavor was noticed when it was irradiated with a dose below 250 krad. After radiation at only 150 krad for saithe and 300 krad for pike the total bacterial counts in the muscle were reduced by nearly 100%. With radiation doses of 150, 250 and 300 krad, the shelf life of pike under refrigeration increased 2.5, 3.5 and 5.2 times, respectively, compared with non-irradiated fish. The shelf-life times listed in the same order were 10, 14 and 21 days, but for non-irradiated fish only 4 days. For saithe the shelf life increased from 23 days (of non-irradiated fish) to 40 days when irradiated with a dose of only 150 krad. When whole fish were irradiated with large doses of 600 and 1200 krad, spoilage caused by bacteria was prevented for a long time while enzymatic spoilage caused by intestines was detected after 38 days as the contents of the intestines became decomposed and the flesh at the side of the abdominal cavity turned soft. (auth) (Finland)

32635 STUDY OF DISINFESTATION OF BANANAS BY GAMMA IRRADIATION. Eric, B.; Le Compte, Judy; Klein, S.; Kricker, W. (Australian Consolidated Industries Technical Centre, Sydney). Food Technol. Aust.; 22: No. 12, 664-7(Dec 1970).

Effects of ionizing energy, from a Cobalt 60 source, on wholesomeness of bananas (Musa Cavendishii), and on eggs and pupae of Queensland fruit fly (Dacus Strumeta Tryoni Froggatt) were investigated. A dose of 20 Krad does not produce significant changes in the nutritional qualities of bananas, measurable by chemical-analytical means. On the other hand this dose is 100 percent effective in preventing the emergence of 70,000 four day old pupae used in these experiments, though a dose of 5 Krad seems to be sufficient for killing eggs and 3 day old pupae of Queensland fruit fly. (Australia)

32636 SOME PROBLEMS OF COMMERCIALIZING IRRADIATED FARM PRODUCTS. Baraldi, Delio. Com. Naz. Energ. Nucl., Notiz.; 16: No. 2, 83-5(Feb 1970). (In Italian).

The economic advantages of using radiation for food processing are reviewed. It is pointed out that radiation processing has been found to extend the storage life of potatoes, onions, oranges, apples, strawberries, mushrooms, bacon, ham, and cereals. Studies have shown that exposure to low-dose radiation has no deleterious effects on the organoleptic properties or nutritional value of these foods, nor does it produce toxic or carcinogenic substance or induce radioactivity in the foods. The cost of using ^{60}Co γ and betatron-produced electrons for food processing is compared, and the economic advantages of using flexible plastic containers and packaging foods before radiation processing are discussed. It is pointed out that consumer acceptance of radiation processed foods will depend on a comprehensive program of consumer education. (TSS)

XUM

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 31778–31780, 32100, and 32766.

32637 (ANL–7745) LITHIUM/SELENIUM SECONDARY CELLS FOR COMPONENTS IN ELECTRIC VEHICULAR-PROPULSION GENERATING SYSTEMS. Interim Technical Summary Report No. 2, November 23, 1969–May 22, 1970. Cairns, E. J.; Gay, E. C.; Kolba, V. M.; Kyle, M. L.; Tevebaugh, A. D.; Trevorrow, L. E. (Argonne National Lab., Ill.). Nov 1970. Contract W-31-109-eng-38. 86p. Dep. NTIS.

The battery program has as its ultimate goal the development of multi-kilowatt lithium/selenium secondary batteries for electrically driven Army vehicles. The shorter-term objective is to develop paste-electrolyte cells having lifetimes of 1000 to 2000 hours and 1000 to 2000 charge-discharge cycles. Seventeen cells were tested during this reporting period showing an ampere-hour efficiency of 0.92 and having the capability of delivering 52% of the theoretical capacity at the 1-hour discharge rate. Cycle lives of 10 to 13 cycles have been obtained during operating times of 120 hours. The life-limiting factor has been the transference of selenium to the lithium electrode. Observed resistivity ratios (resistivity of paste/resistivity of salt) were typically greater (by factors of 1.1 to 1.4) than the theoretical values calculated from the Maxwell equation. The Maxwell values are assumed to represent the minimum attainable resistivity ratio. Six-hundred-hour tests of the corrosion resistance of aluminum, beryllium, aluminum-beryllium mixtures, chromium, Haynes 25, Unitemp 605, niobium, and niobium-1% zirconium alloy to 20 at. % Li–Se mixtures at 375°C indicated that beryllium, aluminum, and chromium are the most resistant materials. (auth)

32638 (CEA-N–1427(1)) TECHNIQUES DEVELOPED IN THE LABORATORIES OF THE METALLURGICAL RESEARCH DEPARTMENT. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1971. 92p. (In French). Dep. NTIS (U. S. Sales Only).

The techniques developed in the laboratories of the metallurgical research department are described. The purpose of the techniques developed and the means available in the laboratories are indicated. Information is included on diffusion with or without external pressure, superficial diffusion, preparation of diffusion couple samples for analysis, counting measurements, compatibility of materials, microanalysis, electromigration, single crystals, the development of high hydrostatic pressure tests, the determination of thermodynamic characteristics, the kinetics of the phase transformations, and the construction of special equipment. (auth) (France)

32639 (CEA-N–1427(2)) TECHNIQUES DEVELOPED IN THE LABORATORIES OF THE METALLURGICAL RESEARCH DEPARTMENT. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr 1971. 102p. (In French). Dep. NTIS (U. S. Sales Only).

The techniques developed in the laboratories of the metallurgical research department are described. The purpose behind the techniques developed and the means available in the laboratories are indicated. The subjects discussed concern mechanical tests (tensile testing, hardness measurements, shattering, creep, and fatigue), fractography, x-ray crystallography, micrography, fabrication, transformation of metals, studies of irradiated metals, electron microscopy, and weldability. (auth) (France)

32640 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. Maerz 1971. Band 5, Heft 3. 320 Referate (Register-Nr.789-1425), 52 Referate (Register-Nr.108 T-159 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. March 1971. Vol. 5, No. 3. 320 Abstracts (Register No. 789-1425), 52 Abstracts (Register No. 108 T-159 T)). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 173p. (In German and English).

32641 LES ELEMENTS DES TERRES RARES. VOLUME 1. (Rare Earth Elements. Volume 1). International Symposium Held in Paris and Grenoble, France, May 5–10, 1969. Paris; Centre National de la Recherche Scientifique (1970). 592p. (In French and English). (CONF-690517-(Vol.1)).

Rare earth metals and alloys were studied, as well as the chemistry, crystallography, and optical properties of rare earth oxides and salts. Separate abstracts were prepared for 22 papers. (France)

For abstracts of individual papers see: 32659, 32660, 32691, 32727–32734, 32780, 32781, 32809, 32810, 32827–32830, 33063, and 33433.

32642 PLUTONIUM-DOKUMENTATION. Referate-Zeitschrift mit Anhang Transplutonium-Elemente. April 1971. Band 5, Heft 4. 211 Referate (Register-Nr.1426-1864), 58 Referate (Register-Nr.160 T-217 T). (Plutonium-Documentation. Abstract Journal with Appendix on Transplutonium Elements. April 1971. Vol. 5, No. 4. 211 Abstracts (Register No. 1426-1864), 58 Abstracts (Register No. 160 T-217 T). Karlsruhe, Ger.; Gesellschaft fuer Kernforschung m.b.H (1971). 127p. (In German and English).

32643 COMPUTER PROGRAM FOR CALCULATING, TABULATING, AND PLOTTING OUTGASSING RATES OF SELECTED GASES. Easton, D. S.; Clausing, R. E. (Oak Ridge National Lab., Tenn.). Scr. Met.; 5: 181-4(Mar 1971).

A computer program for the calculation of outgassing rates has been prepared to assist the evaluation of outgassing of various gases from NERVA fuel elements. The program is based upon the throughput method. It can be used for other outgassing measurements by simple changes in the input constants. The equipment needed to obtain data for the calculations is included in most high-vacuum systems today. Data from a residual gas analyzer and three ion gages permit the analysis of twelve gases simultaneously. Results are available in both tabular and graphical form. The experimental method and the procedure for computing both total outgassing rates and rates based on partial pressure measurement of various gases are given. (auth)

Corrosion and Erosion

Refer also to abstracts 32770, 34334, and 34335.

32644 (CEA-N–1419, pp 135-213) CORROSION STUDIES. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969–May 1970.

The corrosion of zirconium alloys was studied as a function of steam pressure and temperature. Corrosion rates at 1 to 100 bars pressure and 400°C temperature were studied. The effects of these conditions on Zircaloy 2 were negligible up to 100 days. There were no detectable effects of irradiation in water at 290°C on the corrosion of Zircaloy 2 and 4. Corrosion of the alloy Zr–Fe(1%)–Cu(1%) in steam at 500°C was ten times less with chromium plating than without. Various parameters were studied in relation to the behavior of stainless steels in nitric acid solutions. They are the bonding with graphite in the case of silicon steel, effects of the composition and metallurgical state of the steel as a function of the acid concentration, and the influence of the sensitization period on intergranular corrosion. Corrosion of the magnesium cladding of irradiated fuel elements was found to be very slight in a sodium carbonate solution at pH 11.5. Research on the corrosion under stress of nickel-rich alloys has progressed. Structurally hardened Inconel X750 was observed to be especially sensitive to intergranular cracking in water at 300 or 350°C. A study of stainless steel corrosion by fused chlorides was begun, and attacks of an intergranular corrosion were revealed. The oxidation rates of particles of uranium and uranium–iron alloys were investigated under various conditions. As part of the preliminary program on high-temperature reactors, observations were made concerning the behavior of materials in impure helium at high temperature. A study on corrosion of the nuts and bolts of these reactors by carbon dioxide was also initiated. Several studies of in-pile corrosion were completed; these were made on magnesium or zirconium alloys and on ordinary or slightly alloyed steels and give a general picture of the effect of irradiation on oxidation phenomena. Research on the compatibility of ferritic steels with liquid sodium was continued. (J.E.B.)

32645 (GEAP–13559) SODIUM MASS TRANSFER: COMPARATIVE CORROSION AND MICROSTRUCTURAL EFFECTS FOR AUSTENITIC STAINLESS STEELS IN FLOWING SODIUM AT 1300°F. Wozadlo, G. P.; Pohl, L. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Oct 1969. Contract AT(04-3)-189. 36p. Dep. NTIS.

The comparative corrosion response and microstructural effects of Types 304, 316, and 347 stainless steel and Incoloy-800 were studied at 1300°F in sodium flowing in a nonisothermal system.

The major variables examined were the initial structural condition of the alloys and the effects of sample position in the system. Type 316 stainless steel exhibits the lowest corrosion rate, and Incoloy-800 shows the greatest attack. The major microstructural effects were the decarburization of Types 304 and 316 stainless steels, and the intergranular attack of Incoloy-800. The effect of initial alloy structure on corrosion rate was minor. (auth)

32646 (RFP-1586) CORROSION BEHAVIOR OF URANIUM-BASE U-Nb, U-Nb-Zr, AND U-Mo ALLOYS IN HYDROCHLORIC ACID AND OCEAN WATER. Macki, James M.; Kochen, Robert L. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 26 Feb 1971., Contract AT(29-1)-1106. 12p. Dep. NTIS.

The corrosion rates and products for depleted uranium (Tuballoy), U-4.5 wt % Nb, U-6 wt % Nb, U-8 wt % Nb, U-7.5 wt % Nb-2.5 wt % Zr (Mulberry), and U-10 wt % Mo were measured in ASTM ocean water at 26°C, 1N hydrochloric acid (HCl) at 26°C, and 0.1N HCl at 70°C. The six alloys tested, listed in order of increasing corrosion resistance to ocean water, are: Tuballoy, U-4.5 Nb, U-6 Nb, U-8 Nb, Mulberry, and U-10 Mo. In 1N HCl at 26°C the alloys, in order of increasing corrosion resistance, are: Tuballoy, U-4.5 Nb, U-6 Nb, U-10 Mo, Mulberry, and U-8 Nb. In 0.1N HCl at 70°C the positions of U-8 Nb and Mulberry are reversed from those given for 1 N HCl. (auth)

32647 (ZJE-96) REMOTE MEASUREMENT OF INSTANTANEOUS RATE OF UNIFORM CORROSION OF ALUMINIUM ALLOYS IN WATER BY METHOD OF POLARISATION RESISTANCE. Beran, J.; Sulc, J. (SKODA Works, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 15p. Dep. NTIS (U. S. Sales Only).

At parameters approaching actual conditions in the heavy water circuit of an A-1 reactor the applicability of the method of remote measurement of the instantaneous rate of uniform corrosion by means of polarization resistance was successfully verified. The optimum working procedure ensuring the reproducibility of the results was defined. The applicability of the method to the solution of various problems which cannot be solved satisfactorily by conventional methods for corrosion evaluation was demonstrated using practical examples. (auth)

32648 CONSIDERATION OF STABILIZED STAINLESS-STEEL ALLOYS FOR LMFBR FUEL CLADDING. Spalaris, C. N.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 2-3(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32649 DIFFERENCE IN THE EFFECTS PRODUCED BY NON-RADIOACTIVE AND RADIOACTIVE CALCIUM. Subramanyan, N.; Papali, V. (Central Electrochemical Research Inst., Karaikudi, India). Corros. Sci.; 11: 55-71(Jan 1971).

An investigation of the mechanism of Al corrosion inhibition in alkali by Ca^{2+} and citrate ions is reported. The adsorption of radioactive Ca^{2+} on Al from 0.2M NaOH solution saturated with $Ca(OH)_2$ and from the same solution containing Na citrate was also studied. It was found that in the presence of radioactive Ca^{2+}, the corrosion of Al is accelerated, as indicated by negative values of inhibition efficiency, whereas in the presence of inactive Ca^{2+}, the synergistic inhibitive action of Ca^{2+} + citrate is confirmed. With radioactive Ca^{2+} alone, the corrosion of Al is accelerated in spite of the fact that the Ca^{2+} is absorbed. This phenomenon is discussed. (UK)

32650 METALLOGRAPHIC REAGENTS: HASTELLOY N. Breakall, K. L. (Monsanto Research Corp., Miamisburg, Ohio). Contract AT(33-1)-Gen-53. Microstructures; 2: No. 2, 26(Feb-Mar 1971).

The compatibility of Hastelloy N with $^{238}PuO_2$ was tested for 60 days at 1000°C. A photomicrograph is included to show the reaction area of the capsule. The specimen was etched using a solution of 95 parts hydrochloric acid, 2 parts nitric acid, and 3 parts sulfuric acid. (J.R.D.)

32651 STUDY OF ANODIC BEHAVIOUR OF ZIRCONIUM UNDER STRESS IN AQUEOUS SOLUTIONS. Gaur, A. K.; Singh, K. P. (Indian Inst. of Tech., Kanpur). Indian J. Technol.; 8: 359-62(Oct 1970).

Anodic polarization of annealed zirconium wire was studied at various loads of applied stress in 1% nickel chloride and 1% cobalt chloride solutions and at a constant stress of 19 kg/mm^2 in aqueous solutions of ferric chloride, cobalt chloride, nickel chloride, hydrochloric acid, and sulfuric acid of varying concentrations at 25°C. The material yields faster when the applied stress is maintained in the plastic deformation range. The breakdown of the wire occurs much faster in ferric chloride than in cobalt and nickel chloride solutions of the same concentration. No failure of the material has been observed in sulfuric acid solution even at 70% concentration. (auth)

32652 RHEED STUDIES OF THE INITIAL STAGES OF THE OXIDATION OF TUNGSTEN. Lee, A. E.; Singer, K. E. (Cambridge Univ., Eng.). J. Cryst. Growth; 9: 68-73(May 1971).

From first international conference on crystal growth and epitaxy from the vapour phase; Zurich, Switzerland (23 Sep 1970). See CONF-700957.

Reflection-mode high-energy electron diffraction (RHEED) has been used in an ultrahigh vacuum environment to study the initial stages of the oxidation of (100) and (110) tungsten single-crystal surfaces. On exposing the (110) tungsten surface to oxygen at temperatures below 1025°K, nuclei of tungsten trioxide grow. The epitaxial relationships are metal (110)//oxide (11$\bar{1}$) and metal [001]//oxide [1$\bar{1}$0]. The nuclei may be removed by heating the surface in a good vacuum to 1100°K. The growth of nuclei on the (100) tungsten surface is complicated by the faceting of that surface. On unfaceted surfaces, tungsten trioxide nuclei form after small exposures of oxygen, but again only at temperatures below 1025°K. On faceted surfaces, much larger doses of oxygen are required. In both cases the epitaxial relationships are metal (100)// oxide $\{100\} \pm 9°$ and metal [011]//oxide $\langle 100 \rangle \pm 7.5°$. It is shown that the (100) W/oxide system can be described in terms of the metal (110)/oxide system. (auth)

32653 NICKEL-CHROMIUM ALLOY. Maness, Roy F. (to United States Atomic Energy Commission). U. S. Patent 3,574,612. 13 Apr 1971. Filed 3 Feb 1969.

A nickel alloy containing 30 to 35 wt % chromium and 3.5 to 3.9 wt % silicon with small amounts of carbon, titanium and manganese is described which is highly corrosion resistant to hot, liquid, and vapor phase nitric acid solutions, containing iron (III), chromium (VI) and fluoride ions. (Official Gazette)

32654 ELECTRON MICROSCOPIC EXAMINATION OF THIN OXIDE FILMS ON Zr-0.5 WT. PERCENT Nb-1 WT. PERCENT Cr ALLOY. Gadiyar, H. S.; Vijayakar, S. J. (Bhabha Atomic Research Centre, Bombay). Indian J. Technol.; 8: 329-32(Sep 1970).

Thin film formation on Zr-0.5 wt % Nb-1 wt % Cr alloy was studied under different heat treatment conditions by electron microscopy. Extensive postular oxide growth during the initial stages was observed on annealed specimens; the growth also contains large sized secondary precipitates. The film growth on the quenched martensite structure with the least number of precipitates is minimum. It is concluded that as the niobium content is rather small it is possibly retained in solution; the higher rate of film growth may be due to the precipitates of chromium in zirconium. (auth)

32655 CORROSION OF REACTOR MATERIALS. Bradhurst, D. H. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). At. Energy Aust.; 13: 10-15([1970]).

Factors affecting corrosion of reactor materials in current use (Al, Be, Mg, Zr and their alloys, stainless steel and alloys), are briefly described. The major problem presented by stainless steels is cracking resulting from stress corrosion generally due to chloride ion (or high OH^- concentration) and oxygen. Low alloy steels although less expensive, are more prone to corrosion in pressurized and boiling water reactors. Zircaloys, with different amounts of Sn are in widespread use. Although they have proved effective in applications such as cladding in pressurized water reactors, it has been found recently that fast neutron irradiation greatly accelerates corrosion rates of zirconium alloys. Although in Zr-Nb alloys corrosion rate appears unaffected by radiation, the corrosion resistance is inferior to Zircaloy-2. Experimental work concerning the reaction mechanism of corrosion in zirconium alloys is briefly reviewed. (Australia)

32656 OXIDATION OF TD NiC (Ni-20Cr-2 VOL PERCENT ThO_2) BETWEEN 900° AND 1200°C. Giggins, C. S.; Pettit, F. S. (Pratt and Whitney Aircraft, Middletown, Conn.). Met. Trans.; 2: 1071-8(Apr 1971).

The oxidation of TD NiC (Ni-20Cr-2 vol % ThO_2) was studied at temperatures between 900 and 1200°C. Chromium is selectively oxidized in TD NiC and the parabolic rate constants for the growth of the resulting Cr_2O_3 layer are about an order of magnitude lower than those for the growth of Cr_2O_3 on a simple Ni-Cr alloy. The oxidation rate of TD NiC is initially controlled by the interplay of diffusion through the Cr_2O_3 scale and the formation of gaseous CrO_3 but after extended periods of oxidation the rate corresponds to that of the vaporization process. Comparison of results obtained for the oxidation of TD NiC to those for Ni-Cr alloys indicates that the ThO_2 dispersion in TD NiC improves the oxidation properties of this alloy by promoting the selective oxidation of chromium and decreasing the growth rate of the Cr_2O_3 scale. (auth)

XUM

Preparation and Fabrication

Refer also to abstracts 32142 and 32779.

32657 PREPARATION OF CAPACITOR GRADE TANTALUM POWDER. Bose, D. K. (Bhabha Atomic Research Centre, Bombay); Sehra, J. C.; Jena, P. K. Trans. Indian Inst. Metals; 23: 1-5(Jun 1970).

High purity tantalum powder was produced by sodium reduction of potassium tantalum fluoride in an Inconel-lined stainless steel bomb. The influence of experimental variables, such as reduction temperature, amount of sodium and sodium chloride in the charge, and scale of reduction on the yield and quality of the metal was studied. In a typical run, a 72% yield of tantalum metal was achieved by reducing 400 g of potassium tantalum fluoride with 5% sodium in excess of stoichiometric amount in presence of 20 g of sodium chloride in the charge at a reduction temperature of 925°C. The metal powder was found to be suitable for making slug type anodes for electrolytic capacitor. The coarser (+100 mesh) and the finer (<3μ average particle size) fractions of the powder which cannot be used for anode slug conversion was utilized for producing tantalum wire leads for the anode slug. (auth)

32658 USA STANDARD: QUALITY CONTROL FOR PLATE-TYPE URANIUM-ALUMINUM FUEL ELEMENTS. ANSI N 8.1 1967. Hinsdale, Ill.; American Nuclear Society (1967). 4p. Available from American Nuclear Society, Hinsdale, Ill.

The minimum quality control (including inspection) requirements for the manufacture of plate-type uranium-aluminum fuel elements generally used in research and test reactors are outlined. The fuel elements consist of flat or curved plates of a uranium-aluminum alloy that is clad with aluminum. This standard is applicable to fuel elements in which the fuel plates are mechanically fastened or welded to side plates for structural rigidity, but it does not apply to elements in which the fuel plates are brazed to the side plates. (L.C.L.)

32659 PREPARATION AND PROPERTIES OF ULTRA PURE METALS. Spedding, F. H.; Beaudry, B. J.; Croat, J. J.; Palmer, P. E. (Ames Lab., Iowa). pp 25-45 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The various methods for producing ultrapure rare earth metals used by the Ames Laboratory over the years are discussed with particular emphasis on the impurities likely to be present when the metals are produced by the various methods. The analytical methods needed to determine these impurities are indicated. The rare earths are excellent getters for oxygen, carbon, nitrogen, hydrogen, and the halides. Tables of the physical constants of these metals are given (crystalline parameters, tensile properties, resistivity, density, melting and boiling points, specific heat). A number of examples are shown where the presence of such impurities as oxygen, hydrogen, fluorine, tantalum, and tungsten influence the numerical values of the constants measured. A discussion on the handling and storage of pure rare earth metals so as not to introduce impurities is included. (auth) (France)

32660 PREPARATION OF RARE EARTH METALS BY THERMAL REDUCTION OF THEIR OXIDES BY METALS. Schiffmacher, Gerard; Male, Germain; Trombe, Felix (CNRS, Bellevue, France). pp 89-99 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The thermodynamics of the reduction of rare earth oxides by metals was studied. The reaction is possible in vacuum. The rare earth metal must be the only volatile species present if distillation is to occur when the reaction proceeds; the equilibrium is then displaced and the metal produced with a good yield. Thorium is the best reducing agent. Dysprosium and gadolinium were prepared by this method; the other rare earth metals can also be prepared with this method. Rare earth metals can be purified by redistillation with thorium which picks up oxygen. Dysprosium is obtained in this way with less than 100×10^{-6} oxygen. (auth) (France)

32661 5. INTERNATIONALE LEICHTMETALLTAGUNG, LEOBEN, 1968. (Fifth International Meeting on Light Metals, Leoben, 1968). Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). 533p. (CONF-680673).

Papers presented at a symposium held at Leoben in the Austrian Alps in Europe at an unspecified date in 1968 are included. The papers are grouped under the headings: results of metallurgical research; metallurgy and metal physics of Al and its alloys; Ti, Mg, Be; development of Al alloys; working and mechanical properties; latest developments in processing methods; and applications. Separate abstracts were prepared for 13 papers. (M.C.G.)

For abstracts of individual papers see: 31801, 31855, 32141, 32662–32666, and 32692–32696.

32662 CARBIDO-THERMIC PRODUCTION OF HIGH-MELTING METAL ALLOYS, WITH SPECIAL REFERENCE TO TITANIUM ALLOYS. Kieffer, R.; Lihl, F.; Effenberger, E. (Institut fuer Chemische Technologie Anorganische Stoffe, Vienna). pp 66-71 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

The methods used at present for the production and refining of titanium are reviewed and the carbothermic process for the production of high melting metals and their alloys is described in detail with special reference to its suitability for titanium production. By this method metal oxides are converted to the metal by reduction with a metal carbide in a high vacuum. The process is suitable for the production of Ti, V, Nb, Ta, Cr, Mo, and W as well as alloys of these elements. (auth)

32663 INVESTIGATIONS ON THE STABILIZING OF UAl_3 IN NUCLEAR FUELS RICH IN ALUMINUM. Exner, H. E.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). pp 77-83 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Aluminum alloys with 2 to 10 at.% uranium have long been used as fuel for water-cooled and moderated reactors. Higher uranium percentages lead to difficulties due to the formation of a brittle UAl_4-phase. The addition of certain elements counteracts this tendency by preventing the peritectic transformation of UAl_3 to UAl_4. It has been suggested that this may be due to a simple reduction in the rate of transformation but an investigation of the ternary system (Al–U–Zr, Al–U–Ni) has proved that the UAl_3-phase in the stabilized alloys is in thermodynamic equilibrium with the aluminum matrix. Systematic investigations have shown that the amount of the bi-phase Al–UAl_3 is determined solely by the solubility of foreign elements in the UAl_3-phase. (auth)

32664 TITANIUM PRODUCTION, TECHNOLOGY, AND RESEARCH IN JAPAN. Hashimoto, U. pp 185-96 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

The following topics are discussed: titanium ore deposits in the world and the present position in Japan; production of Ti and Ti sponge (quality control in a titanium plant and properties of titanium sponge, particularly of high-purity titanium and titanium containing oxygen); melting, casting, semi-manufacturing, heat treatment, and welding of titanium; properties of the alloys used in Japan (TiAl8Co4, TiAl5Mn3, TiAl5Cr2Fe/Mo/1, TiAl5Fe1.5-CrMo, TiTa); problems of fundamental research, industrial specifications covering titanium products in Japan; and uses. (auth)

32665 PRODUCTION OF HIGH GRADE FORGINGS IN TITANIUM AND TITANIUM ALLOYS: THEIR PROPERTIES AND MACHINABILITY. Bisanz, H.; Fischer, Chr.; Tarmann, H. pp 202-8 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

The production of titanium alloy forgings is described and illustrated by means of practical examples. Directions are given for selecting the cross section and structural condition of forging stock to produce the best possible mechanical properties. Avoidance of oxygen, nitrogen and hydrogen pick-up during preheating to the forging temperature and transformations in the solid state must also be considered. The forging properties of titanium and titanium alloys are compared with those of a heat treatable CrNiMo-steel. The influence of heat treatment on the mechanical properties attainable is discussed and notes are given on machinability, also with reference to the CrNiMo-steel. (auth)

32666 MACHINABILITY OF ALUMINUM ALLOYS. Zoller, H.; Enzler, G.; Fornerod, J. C. (Forschungsinstitut der Alusuisse, Neuhausen, Switzerland). pp 283-8 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Effects of additions of lead, bismuth, and cadmium made to AlCu and AlMgSi alloys as chip-breakers were investigated. Electron probe microanalyzer investigations show that in the absence of magnesium these additions are always present in inclusions formed during solidification of the metal. The melting points of the inclusions vary widely according to composition. If Mg is present as an alloying element an intermetallic compound is formed between bismuth and magnesium so that the chip-breaking inclusions lose most of their bismuth. Machining tests show that the melting point of the inclusions somehow influences the size of the chips. As soon as the heat generated in machining melts the inclusions shorter chips are produced. It is now presumed that the volume increase during melting produces additional stresses in the chip which, together with the stresses originating from machining, exceed the strength of the solid solution and lead to the fracture of the chip. (auth)

32667 COMPOSITE MATERIAL FOR USE IN NUCLEAR REACTORS. **Borgstedt, Hans Ullrich; Ruhle, Manfred; Wincierz, Peter (to Metallgesellschaft Aktiengesellschaft). British Patent 1,225,896. 24 Mar 1971. Priority date 14 Mar 1968, Germany.**

Corrosion-resistant composites for use as reactor structural materials and for fuel cladding are described. The composite material consists of V, Ti–0.1 to 50%, Nb–0 to 40%, Zr–0.5 to 10%, Cr–0 to 20%, Mo–0 to 25%, Ta–0 to 20%, W–0 to 20%, Al–0 to 15%, Ni–0 to 10%, Be–0 to 1%, Si–0 to 3%, Fe–0 to 10%, and rare earths or Y–0 to 1%. (J.R.D.)

32668 LOW-CYCLE FATIGUE STRENGTH OF NOZZLE-END WELDMENTS FOR REACTOR PRESSURE VESSELS. **Kusumoto, Sho; Murakami, Yukitaka (Hitachi Ltd., Ibaraki, Japan). Hitachi Hyoron; 51: 868-72(Jul 1969). (In Japanese).**

Low-cycle fatigue strength influenced by the notch constructed at the imperfectly melt-in weldment between the nuclear pressure vessel nozzle-end and the pipe, especially the core spray nozzle and the control rod housing nozzle is examined. The experiments were performed using a two dimensional model. It was found that micro-cracks were formed very early and the fracture life was limited by the crack propagation. The life under the same nominal stress range was unrelated to the plate thickness. The fatigue strength of the specimen compared with that of flat plate by the Manson method. The relations between the displacement and nominal stress range in the case of this experiment are described. (Japan)

32669 TUNGSTEN NEWS, APRIL 1971. **Tungsten News; 1-17(Apr 1971).**

A review of development activities associated with W is presented. Research results are summarized on W metal, W-base alloys, W as an alloying element, W compounds, and production of W. 324 references are included. (J.R.D.)

32670 CATHODIC VACUUM ETCHING: A TECHNIQUE FOR THE SURFACE PREPARATION OF IRRADIATED MATERIALS PRIOR TO OPTICAL AND ELECTRON METALLOGRAPHY. **Bainbridge, John Evelyn (Atomic Energy Research Establishment, Harwell, Eng.). Prakt. Metallog.; 8: 159-70(Mar 1971). (In English and German).**

Cathodic vacuum etching has, for several years, been used on irradiated material to give clean, reproducible etched surfaces suitable for optical and electron metallography. The basic design of an etcher is discussed together with a summary of the problems which have arisen during operation. (auth)

32671 COMPACTING AND SINTERING PROPERTIES OF ULTRA-FINE TUNGSTEN POWDERS. **Yamamoto, Hiroshi (Hitachi Ltd., Tokyo). Funtai Oyobi Funmatsuyakin; 17: No. 5, 198-205(Jan 1971). (In Japanese).**

The effects of particle size on the void volume of green and sintered compacts were studied with tungsten powders from 2.9 to 0.022μ in average diameter. The void volume of green compacts increased with decreasing particle size to 0.3μ but remained essentially constant with further decrease in particle size. The sintering process for 0.022μ-powder consists of three stages. The first stage is characterized by an activation energy of 79 kcal/mole and an active surface diffusion mechanism. The activation energies of the second and third stages are 102 and 124 kcal/mole respectively, the latter is comparable to that expected in volume diffusion. In the sintering of 0.022μ-powder, the first stage is important and a 50 to 60% reduction in void volume was obtained. On the other hand, for coarser powders, 60 to 80% reduction in void volume was observed after the second stage. (auth) (Japan)

32672 IMPROVEMENTS RELATING TO THE EXPLOSIVE WELDING OF A PLUG TO A TUBE OR OF TUBES TO EACH OTHER. **Golinelli, Paolo; Holtbecker, Helmut; Montagnani, Mario; Remmerswaal, Juost Louis; Verzeletti, Guido (to EURATOM). British Patent 1,225,135. 17 Mar 1971. Priority date 1 Dec 1967, Germany.**

Methods for explosive welding of metal plugs to metal tubes such as fuel tubes are described. Laminar explosive charges and deformable buffer rings for transmitting the shock waves to the components being welded were used. These components were arranged in telescoped relation with the weld zone. The explosion produced a welded front which progresses uniformly over the entire weld zone. (J.R.D.)

32673 CRYSTAL GROWTH AND EPITAXY FROM THE VAPOUR PHASE. **Proceedings of the First International Conference, Zurich, Switzerland, 23–26 September 1970. Kaldis, E.; Schieber, M. (eds.). J. Cryst. Growth: 9: 1-371(May 1971). (In several languages). (CONF-700957).**

Forty-nine papers and 6 abstracts are arranged into three sections on gas transport and condensation (gas phase; adsorption and surface reactions; nucleation, epitaxy and growth); epitaxy of semiconductors (Si, Ge, III-V compounds); and growth of crystals and layers (II-VI compounds, elements, binary and ternary compounds, miscellaneous methods and materials, whiskers). Unpublished papers are listed together with indexes of authors, subjects, and compounds. A separate abstract was prepared for each of five papers. (D.L.C.)

For abstracts of individual papers see: 32652, 32674, 32675, 32740, and 32741.

32674 EFFECT OF TEMPERATURE AND SATURATION RATIO ON VAPOR GROWN CADMIUM CRYSTALS. **Loper, C. R. Jr. (Univ. of Wisconsin, Madison); Rasmussen, D. H.; Koelling, H. A. J. Cryst. Growth: 9: 217-27(May 1971).**

From first international conference on crystal growth and epitaxy from the vapour phase; Zurich, Switzerland (23 Sep 1970). See CONF-700957.

The growth of cadmium crystals from the vapor has been studied as a function of vapor saturation and growth temperature. The temperature of growth was varied from 240 to 300°C and the saturation ratio (actual partial pressure of vapor at the crystal over the equilibrium vapor pressure of cadmium at the growth temperature) was varied from 2 to 30 at each growth temperature. The morphology of the crystal growth was observed to change from whiskers at low saturation ratios to platelets at higher saturation ratios. The temperature dependence of the critical saturation ratio was found to conform to the temperature dependence of two-dimensional nucleation on the crystal, as presented by Hirth and Pound. (auth)

32675 EPITAXIAL GROWTH OF CODEPOSITS OF MOLYBDENUM–TUNGSTEN ON MOLYBDENUM BY REDUCTION OF GASEOUS FLUORIDES. **Gillardeau, J. (CEN de Saclay, Gif-sur-Yvette, France); Faron, R.; Bargues, M.; (and others). J. Cryst. Growth: 9: 255-62(May 1971). (In French).**

From first international conference on crystal growth and epitaxy from the vapour phase; Zurich, Switzerland (23 Sep 1970). See CONF-700957.

A study on the epitaxial growth of molybdenum–tungsten alloys on molybdenum substrates is reported. The method adopted is based on hydrogen reduction of the hexafluorides MoF_6 and WF_6 at low pressure and high temperature. Although the deposits formed under these conditions are oriented on a given molybdenum grain, they have the appearance of the adjacent nuclei identically oriented. The faces of these nuclei are generally separated, which leads to the presence of many cracks in the deposit. At low ($H_2/MoF_6 + WF_6$) ratios, it is possible to eliminate the cracks in the epitaxial deposits. (auth)

32676 NICKEL-BASE ALLOY. **McCoy, Herbert E. Jr. (to United States Atomic Energy Commission). U. S. Patent 3,576,622. 27 Apr 1971. Filed 29 May 1968.**

An improved nickel-base alloy is described which contains as essential alloying ingredients 11 to 13 wt % molybdenum, 6 to 8 wt % chromium, 0.02 to 0.5 wt % carbon, up to 1.0 wt % of a boride forming element selected from titanium, zirconium, and hafnium, up to 4 wt % of at least one strengthening agent consisting of tungsten, tantalum, vanadium, and niobium, and the balance nickel. (Official Gazette)

32677 PREPARATION AND PROPERTIES OF ELECTRONIC MATERIALS FOR COMPUTERS. **Electronic Materials Conference Proceedings, New York, August 30–September 2, 1970. Met. Trans.; 2: 621-924(Mar 1971). (CONF-700839).**

XUM

A total of 27 papers were presented at the conference. A separate abstract was prepared for each of 2 papers. The remaining 25 papers were not within the scope of NSA. (G.M.C.)

For abstracts of individual papers see: 32678 and 32679.

32678 STRESS AND RESISTIVITY CONTROL IN SPUTTERED MOLYBDENUM FILMS AND COMPARISON WITH SPUTTERED GOLD. Blachman, Arthur G. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.). Met. Trans.; 2: 699-709 (Mar 1971).

From eighth electronic materials conference; New York, N. Y. (Aug-Sep 1970).

Dc bias sputtering was used to obtain molybdenum films with total stress varying controllably from $+10^{10}$ to $<-10^{10}$ dyne per sq cm. These results were obtained for films approximately 3000 Å thick sputtered onto thermally oxidized silicon at substrate-holder temperatures from 70 to 230°C, with dc bias as the major parameter. Films of 1000 Å exhibit an even greater range of stress. Bias and substrate-holder temperature control also permits minimization of resistivity which is correlated with the impurity content of the films. Electron microprobe analysis shows a high oxygen content for zero-biased films, which decreases with increasing negative bias, as does the resistivity. The argon (sputtering ambient) content of the films increases as the negative bias increases from −110 to −200 volts. These changes with bias are qualitatively what would be expected based upon the preferential resputtering of oxygen and upon the embedding of the more energetic argon atoms at higher bias. The stress level, resistivity, and impurity content of dc bias sputtered gold films exhibit much less variation with bias than for molybdenum films, which is consistent with the difference in oxide formation properties of the two metals. (auth)

32679 CAPILLARY-INFILTRATED CONDUCTORS IN CERAMICS. Chance, D. A.; Wilcox, D. L. (IBM Corp., Hopewell Junction, N. Y.). Met. Trans.; 2: 733-41(Mar 1971).

From eighth electronic materials conference; New York, N. Y. (Aug-Sep 1970).

The infiltration of high conductivity metals into capillaries in ceramic structures have been reported by Schwartz and Wilcox. Others have used the infiltration concept for the fabrication of composite structures for a variety of reasons, thermal expansions, machinability of hard metals, and so forth. In electronic applications, that is the fabrication of ceramic structures for support and interconnection of devices, the reasons for infiltration are evident. They provide highly conductive paths in a controlled manner for dimensions and configurations which approach those of device structures. Experiments were conducted to investigate the wetting and spreading of copper on molybdenum metallized alumina slips. Various surface-active and viscosity-active metals were added to the copper, and ambient conditions were varied. The results indicate that the primary controlling parameters for wetting are the ambient conditions. The infiltrations of copper into porous molybdenum lines were observed by x-radiographs of experimental substrates after increments of time at 1120°C. The substrates were moved from an average temperature of 1040°C into a hot zone at 1120°C, then after an incremental soak time were returned to 1040°C, and subsequently cooled for observation. The penetrations of copper are clearly seen on the x-radiographs so that the process of infiltration may be closely monitored. The results indicate that reliable infiltrations at predictable rates may be obtained. Thus, the technique is a reliable means of achieving high conductivity metals within a ceramic substrate. There is no indication of a limitation on penetration distance on well formed lines as small as 5 mil wide. Electrical conductivity of infiltrated lines was observed to follow the volume relationship: $\sigma = \nu_{Cu}\sigma_{Cu} + \nu_{Mo}\sigma_{Mo}$, where σ = conductivity and ν = volume proportion. (auth)

Properties Evaluations

Refer also to abstracts 32153, 32154–32156, 32668, 32811, 33433, 33448, 33463, and 34392.

32680 (AE–412) STUDY OF THE RING TEST FOR DETERMINATION OF TRANSVERSE DUCTILITY OF FUEL ELEMENT CANNING. Anevi, G.; Oestberg, G. (Aktiebolaget Atomenergi, Studsvik (Sweden)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

A ring test is studied for determination of transverse ductility of fuel element canning. The theoretical aspects of the deformation in the transverse ductility test are discussed as well as practical problems in its performance. Particular emphasis is given to the influence on ductility of the length of the specimen and the friction between specimen and plug. Applications in post-irradiation examination are described. (auth) (Sweden)

32681 (COO–1799-6) DIFFUSION AND PRECIPITATION OF INERT GASES IN METALS. Technical Progress Report, June 1, 1970–February 28, 1971. Cost, James R. (Purdue Univ., Lafayette, Ind. School of Materials Science and Metallurgical Engineering). 28 Feb 1971. Contract AT(11-1)-1799. 6p. Dep. NTIS.

Results of precipitation kinetics studies in Al–He systems by measurements of residual electric resistance, electron microscopy, and low temperature heat capacity are reported. In other work preliminary measurements of internal friction in He–Nb systems are reported. (J.R.D.)

32682 (NYO–2150-69) LOW-TEMPERATURE LATTICE THERMAL CONDUCTIVITY OF HIGH-PURITY TUNGSTEN. Wagner, D. K. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Mar 1971. 15p. Dep. NTIS.

Measurements of the lattice thermal conductivity κ_g of high-purity tungsten were made at low temperatures (1.5 to 6°K) by suppressing the electronic thermal conductivity with a magnetic field. The results show that κ_g is proportional to T^2 as expected for a pure metal in which the phonons are scattered mainly by the conduction electrons. The measured value of κ_g is $(0.5 \pm 0.05)T^2$ mW/cm-K. (auth)

32683 (ORNL–4430) EFFECT OF OXYGEN, HEAT TREATMENT, AND TEST TEMPERATURE ON THE COMPATIBILITY OF SEVERAL ADVANCED REFRACTORY ALLOYS WITH LITHIUM. Sessions, C. E.; DeVan, J. H. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 48p. Dep. NTIS.

The niobium alloys D-43, B-66, FS-85, Cb-752, and Cb-753 and the tantalum alloy T-111 were tested in static lithium at 500 and 1000°C. The compatibility of the alloys with lithium was examined from the standpoint of the oxygen content and prior heat treatment of each alloy. Specimens of the alloys were internally oxidized at 1000°C under partial pressure of 9×10^{-6} torr O_2 to produce concentrations of 100 to 3000 ppM O. Some of these specimens were then heat treated in vacuum at 1000, 1300, and 1600°C. Oxygen-contaminated specimens exposed to lithium without prior heat treatment exhibited Widmanstätten precipitates at 500°C for high oxygen concentrations and heavy intergranular attack at 1000°C for all levels of oxygen contamination. The susceptibility to attack of these oxidized alloys that had not been heat treated was eliminated by a heat treatment at 1300 to 1600°C before exposure to lithium. The resistance to corrosion afforded by heat treating the contaminated alloys is attributed to homogenization and subsequent precipitation of the oxygen present as either hafnium or zirconium oxide. Corrosion induced by oxygen was greatest in the case of T-111, and the susceptibility of the niobium alloys increased in the order FS-85, B-66, D-43, Cb-752, and Cb-753. Hydrogen embrittlement and cracking of the alloys was encountered during decontamination after testing when either water or alcohol was used to remove the residual lithium films from the test coupons. Samples that were recrystallized and exposed to lithium at 1000°C were more susceptible to hydrogen embrittlement than samples exposed to lithium at 500°C. Hydrogen embrittlement could be eliminated by removing the residual lithium by vacuum distilling or by organic solvents that react more slowly than alcohol. (auth)

32684 (RFP–1554) METHOD FOR DETERMINING THE FRACTURE STRENGTHS OF LOW-DUCTILITY MATERIALS SUBJECTED TO SHOCK-WAVE LOADING. Avery, John G.; Norris, James F. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Mar 1971. Contract AT(29-1)-1106. 9p. Dep. NTIS.

A novel method is introduced for testing the resistance of a brittle material to fracture when it is subjected to shock wave loading. An inexpensive and simple mechanical method is used to measure the peak stress of the shock wave; the wave may be generated by explosive detonation or electrical discharge. The method of testing makes it possible to compare between different materials, or different processing variables on the same material, to determine the optimum processing and material for the particular application. (auth)

32685 (WARD–4210-T-3-2) STAINLESS STEEL CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending December 31, 1970. Ray, William E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Feb 1971. Contract AT(30-1)-4210. 42p. Dep. NTIS.

Post-test stainless steel specimen characterizations using strain profile measurements, local wall thickness reductions, rupture morphology, and metallography were continued. Long term 1300°F, air atmosphere, stress rupture tests of both plug drawn and planetary swaged Type 316 stainless steel tubing have

shown that for hoop stresses below about 12,000 psi, annealed tubing has both longer stress rupture life and greater rupture ductility than 20% cold worked tubing. Correlation of rupture morphology with twelve combinations of material variables and with stress rupture conditions has shown that rupture morphology is influenced strongly by the level of cold work, the grain size, and to lesser extent by the fabrication method and melting practice. For a given material there appears to be a stress level below which only pinhole rupture is observed and above which mixed-type ruptures occur. Electro-discharge machined standards for eddy current and ultrasonic testing have been procured from two manufacturers. An order has been placed for wall thickness and eccentricity standards to be fabricated from Carpenter heat number 91695, double vacuum melted, Type 316 stainless steel. These standards, in addition to the notch standards, will allow tubing characterization using eddy current, ultrasonic, and air gage techniques. Preliminary NDT measurements were made on ten tubes of ARD double vacuum melted, 20% cold worked tubing to calibrate the NDT equipment, define procedures, and to select a length of tubing for the preliminary stress rupture tests on intentionally defected specimens. Statistical analysis of the eddy current response to standard defects of various sizes, orientation, and locations has been initiated. Three furnaces have been converted to argon atmosphere stress rupture testing facilities; conversion of additional furnaces is in progress. To date, five runs have been completed to test these units. A uniaxial creep unit is now operational, using a microscope to measure deformation on a platinum gage attached to the specimen: creep measurements are being made on lot number 42402, 20% cold worked, vacuum melted Type 316 stainless steel tubing. The test conditions are 1200°F and 15,000 psi stress in vacuum. A second unit is nearing completion in which a test at 1200°F and 12,000 psi is planned. A surface replica procedure was developed for nondestructive evaluation of surface defects. Although there is still some difficulty in removing replicas from the internal surface of tubing, an acceptable replica has been made of the full inside surface of a 15-inch length of tubing. This procedure will be used in the next report period to evaluate internal surface defects and to measure the internal electro-discharge machined notches in the nondestructive testing standards. An immersion density facility and procedure are being developed to measure density of tubing to better than 0.02%. The objective of this effort is to determine density changes as function of stress and temperature during stress rupture. (auth)

32686 ZIRCONIUM–COPPER ALLOYS USED IN CLADDING FUEL ELEMENTS OF HEAVY WATER-GAS REACTORS. Orsier, G.; Vidal, H. (CEA, Saclay, France). Bull. Inform. Sci. Tech. (Paris); 152: 37-46(Oct 1970). (In French).

Under certain conditions zirconium–copper alloys can be used as cladding material in reactors of the heavy water–gas type. These alloys become brittle by diffusion of oxygen from the coolant gas (CO_2) and from the fuel (UO_2). This embrittlement increases with temperature, which means that the working temperature must be restricted so that the alloy retains a certain minimum ductility when the fuel element reaches the end of its lifetime. The problems raised by the weak mechanical properties of these materials at working temperatures are discussed. An account is given of the experience acquired with experimental irradiations and of the present manufacturing program which envisages loading the EL 4 reactor with a certain number of fuel elements of this type. (auth) (France)

32687 STUDY OF A ZIRCONIUM–COPPER CLAD FUEL ELEMENT FOR EL 4. Orsier, G.; Chagrot, M. (CEA, Saclay, France). Bull. Inform. Sci. Tech. (Paris); 152: 47-53(Oct 1970). (In French).

The advantages of using a zirconium–copper alloy as cladding material for the fuel elements of the EL 4 reactor are discussed. A description of a laboratory manufactured Z2 type zirconium–copper clad element for EL 4 is given. The improvements envisaged, the manufacturing processes, and some economic data are presented. (auth) (France)

32688 ELECTROTRANSPORT OF NICKEL IN MOLYBDENUM–NICKEL ALLOYS. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D.; Statsenko, V. M. (Inst. of Problems of Science of Materials, Kiev). Fiz.-Khim. Mekh. Mater.; 6: No. 4, 104-6(1970). (In Russian).

The electrotransport and diffusion of Ni in Mo–Ni alloys was studied using ^{63}Ni as a tracer. Interpretation of calculation results showed that scattering of conductivity electrons plays a role in transport. Results of calculations of Ni atom ionization show that atoms in the alloy are electron donors. Diffusion process temperature parameter findings indicate that the Ni is in solid solution. (tr-auth)

32689 ELASTIC PROPERTIES OF VANADIUM. I. TEMPERATURE DEPENDENCE OF THE ELASTIC CONSTANTS AND THE THERMAL EXPANSION. Bolef, D. I.; Smith, R. E.; Miller, J. G. (Washington Univ., St. Louis). Phys. Rev., B; 3: 4100-8(15 Jun 1971).

The thermal expansion and adiabatic elastic constants of several single crystals of vanadium were investigated over the temperature range 4.2–300°K. Although certain anomalies in the thermal expansion and in the elastic constants were observed at specific temperatures, emphasis is placed on the overall elastic properties of vanadium, and attention is focused on those specimens in which the anomalies were less striking. The 4.2°K values of the elastic constants of a specimen exhibiting essentially no anomalous behavior were measured to be $C_{11} = 23.70$, $C_{44} = 4.708$, $C' = 5.793$, $C_{12} = 12.20$, and the bulk modulus $B = 15.98$, all in units of 10^{11} dynes/cm^2. Except for $C_{44}(T)$, the overall temperature dependence of the elastic constants agrees with that predicted by current theoretical models. $C_{44}(T)$, however, exhibited an upward concavity over much of the temperature range, and was characterized by an athermal value lower than the measured 4.2°K value. Above 150°K, the coefficient of thermal expansion was approximately constant for those specimens showing no anomalies, with a value $\alpha \cong 8.5 \times 10^{-6}$/°K. Below 150°K, α decreased monotonically to 0 at ~10°K. The value of the Debye temperature extrapolated to 0°K was calculated to be Θ_D(elastic) = 403°K. (auth)

32690 ELASTIC PROPERTIES OF VANADIUM. II. THE ROLE OF INTERSTITIAL HYDROGEN. Bolef, D. I.; Smith, R. E.; Miller, J. G. (Washington Univ., St. Louis). Phys. Rev., B; 3: 4108-15(15 Jun 1971).

A detailed study was made of anomalies in the temperature dependence of the thermal expansion and of the elastic constants of several single crystals of vanadium. The anomalies were characterized by a transition temperature T_c, different for each crystal and lying in the temperature range 160 to 270°K. A simple thermodynamic theory based on a hydride-precipitation model due to Westlake accounts for the experimental results. The applicability of this model points to the precipitation of interstitial hydrogen as the cause of the observed anomalies. (auth)

32691 PHYSICAL AND CHEMICAL PROPERTIES OF RARE EARTH ALLOYS. Savitskii, E. M. (Inst. of Metallurgy, Moscow); Terekhova, V. F.; Torchinova, R. S.; (and others). pp 47-79 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

New results on binary diagrams for the rare earths alloyed with Fe, V, Hf, Pt, Ca, and oxygen are presented. The changes in the physical properties of alloys in the binary and ternary systems were investigated as a function of rare earth contents. Results obtained from studies of single yttrium crystals are presented. The potential uses of rare earth alloys in electronics and electrotechnics are discussed. (France)

32692 THERMOCHEMISTRY OF ALUMINIDES. Neckel, A.; Nowotny, H. (Univ., Vienna). pp 72-6 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Thermochemical data are given for the aluminides of vanadium, niobium, and tantalum, and a calorimeter designed for determining the heats of formation of these compounds is described. Further calorimetric investigations, with special reference to the Nb–Al system, are described in detail and the results discussed with reference to literature data for other aluminides of transition metals. (auth)

32693 PRESENT POSITION OF THE TITANIUM ALLOYS. Ruedinger, K. pp 197-201 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Starting from the structure of titanium alloys and the influence of addition elements on titanium alloy formation, the distinctive properties of the alloy groups are discussed and the most important industrial titanium alloys are described with reference to their applications. Further, questions of deformability, weldability and stress corrosion, as well as the present position of, and future market development for, titanium alloys are dealt with. (auth)

32694 INFLUENCE OF TRANSFORMATION CONDITIONS IN THE FORGING AND EXTRUSION PROCESSES ON THE MECHAN-

XUM

ICAL STRENGTH PROPERTIES OF TITANIUM-ALLOYS. van Kann, H. pp 209-11 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Below the range of β-transformation titanium shows a high degree of ductility combined with low thermal conductivity and therefore tends to local overheating and β-transformation during hot forming. With regard to ductility and fatigue characteristics β-transformation is undesirable. Therefore slow forming speed should be aimed at which, with large forgings, should be carried out on high power hydraulic forging presses. (auth)

32695 DEVELOPMENTS IN MAGNESIUM ALLOYS. Fisher, P. A. pp 212-20 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Developments of technology and use of magnesium alloys over the past few years are reviewed. Details of new cast and wrought alloys having improved strength to weight ratio; development in the use of cast alloys to provide higher guaranteed strength and development in surface protection procedures are outlined. Details are given of significant new constructional uses of magnesium alloys. (auth)

32696 SOME PROBLEMS OF THE METALLURGY AND TECHNOLOGY OF BERYLLIUM. Romeiser, H. J.; Roesler, U. pp 233-8 of 5. Internationale Leichtmetalltagung, Leoben, 1968. Duesseldorf, Ger.; Aluminium-Verlag GmbH (1968). (In German).

From 5th International Light Metal Congress Conference, Leoben, Austria. See CONF-680673.

Beryllium, with its high permeability to thermal neutrons, is an interesting metal for use in nuclear technology. It has, moreover, a favorable strength/density ratio, which makes it an interesting engineering material for space exploration. But the ductility of beryllium at ordinary and elevated temperatures is low and, so far, no satisfactory means have been found for its improvement. Radiation at elevated temperatures produces further embrittlement. Difficulties also arise in welding and soldering beryllium. The chief problem with regard to welding is that of hot shortness and careful control of temperature in the preheating, welding and cooling stages if crack-free welds are to be produced. Special problems in soldering are concerned with difficulties in wetting and the formation of brittle intermetallic phases. These can largely be avoided by choice of suitable solder compositions and soldering conditions as well as by special surface treatments, e.g., silvering, of the surface to be soldered. (auth)

32697 REACTION OF TUNGSTEN WITH DIE MATERIAL IN HOT PRESSING. Karpinos, D. M.; Kravchenko, A. A.; Pilipovskii, Yu. L.; Tkachenko, V. G.; Shamatov, Yu. M. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 831-4(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 61-5(Oct 1970).

The reaction of tungsten with graphite die sets does not prevent parts from tungsten and its pseudoalloys from being produced by hot pressing. In pressing with isothermal holding for 60 min and a heating time of 1 hr (such periods are adequate in the manufacture of large-sized components), the thickness of the resulting carbide layer is ~1 mm for tungsten and ~0.6 mm for the pseudoalloys. The penetration of carbon into the part is negligible, particularly in the pressing of tungsten pseudoalloys. Both the thickness of the carbide layer and the depth of carburization may be reduced by increasing the rate of heating. (auth)

32698 HOT PRESSING OF THE TRANSITION METALS AND THEIR CARBIDES IN THEIR HOMOGENEITY REGIONS. Samsonov, G. V.; Koval'chenko, M. S.; Petrykina, R. Ya.; Naumenko, V. Ya. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 713-16(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 17-22(Sep 1970).

A study was made of the densification kinetics during sintering by hot pressing of the transition metals, Ti, Cr, Nb, Mo, Re, and W, and also of the carbides TiC_x, ZrC_x, HfC_x, NbC_x, and TaC_x in their homogeneity regions. The energies of activation for sintering by hot pressing of the transition metals and their carbides within their homogeneity regions were determined. It was established that, for the pure metals, the energy of activation increases with rise in statistical weight of atoms with stable d^5 configuration (SWASd^5C). For the carbide phases of the transition metals of groups IV–V, the energy of activation grows with decrease in the stability of the sp^3 configurations of the carbon atoms. (auth)

32699 OSOBO TUGOPLAVKIE ELEMENTY I SOEDINENIYA. SPRAVOCHNIK. (Highly Refractory Elements and Compounds. Reference Book). Kotel'nikov, R. B.; Bashlykov, S. N.; Galiakbarov, Z. G.; Kashtanov, A. I. Moscow; Izdatel'stvo Metallurgiya (1969). 375p.

This reference book contains information on the physicomechanical properties of a large number of refractory elements and their compounds with a melting point above 2500°C. These materials include artificial graphite, molybdenum, niobium, osmium, rhenium, tantalum, tungsten, and a large group of various borides, carbides, nitrides, and oxides. Numerical data on the crystalline, chemical, thermodynamic, thermophysical, electrical, optical, and nuclear properties of these materials, and also their vapor pressures and vaporization rates, are given for temperatures up to 6000°C. (auth)

32700 THERMAL PROPERTIES OF NIOBIUM AT HIGH TEMPERATURES. Makarenko, I. N.; Trukhanova, L. N.; Filippov, L. P. (Crystallography Inst., Moscow). High Temp. (USSR) (Engl. Transl.); 8: 628-31(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 667-70(May-Jun 1970).

The following thermo physical properties were measured for Nb monocrystals and polycrystals at 1100 to 2400°K: thermal conductivity, thermal diffusivity, specific heat, electric conductivity, and monochromatic and integrated degrees of blackness. The Lorentz number was also determined. (D.L.C.)

32701 SPREADING KINETICS OF LIQUID METALS ON SOLID SURFACES. I. SYSTEMS Mo–Sn AND Co–In. Lesnik, N. D.; Pestun, T. S.; Eremenko, V. N. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 849-53(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 83-9(Oct 1970).

A study was made of the spreading kinetics of tin over molybdenum in the temperature range 500 to 1000°C and of indium over cobalt in the temperature range 200 to 500°C. It is shown that the spreading process in the systems investigated is completed in 5×10^{-3} to 1×10^{-2} sec. Within this time, equilibrium is attained. Raising the temperature improves wetting and increases the work of adhesion. The frequently observed slow variation of contact angle over a long period of time in metallic systems exhibiting no intersolubility of components is due to the presence of surface contaminants on the solid metal being wetted and may be eliminated by suitable vacuum heat treatment. A comparison of values of adhesion work determined experimentally and calculated by Zadumkin's method permits the conclusion that, even in the absence of intersolubility, the work of adhesion is governed by the energy of the metallic bond generated at the interface between a liquid and a solid metal. (auth)

32702 DIFFUSION OF COBALT IN PLUTONIUM. Dapht, M. J. (Nuclear Research Centre, Negev, Israel); Dariel, M. P.; Rosen, A. Scr. Met.; 5: 191-3(Mar 1971).

Experimental measurements of the solute diffusivity of Co in Pu are described. It was found that diffusion values are of the same order as the self-diffusion coefficients of Pu. It is noted that further experiments are necessary to verify whether the anomalous penetration can be attributed to low solubility of Co in Pu or to surface potential effects. (J.R.D.)

32703 EFFECT OF CARBON ON THE SURFACE TENSION AND DENSITY OF LIQUID VANADIUM, NIOBIUM, AND MOLYBDENUM. Elyutin, V. P.; Kostikov, V. I.; Pen'kov, I. A. (Moscow Inst. of Steel and Alloys). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 736-9(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 46-51(Sep 1970).

Results of experiments are reported in which thin layers of carbon black were applied to test specimens of metals in periodic Groups V and VI. The metals, in the form of rods, were heated to 1400° to 1450°C. Liquid metal drops from the rods were collected in cooled crucibles for examination and were photographed during fall. The metal drops were held for 1 minute in molten state to allow for mixing. Density and surface tension measurements on the metals were made. (J.R.D.)

32704 BERYLLIUM METAL AS A NEUTRON MODERATOR AND REFLECTOR MATERIAL. Beeston, J. M. (Idaho Nuclear Corp., Idaho Falls). Nucl. Eng. Des.; 14: 445-74(Feb 1971).

The properties of beryllium are reviewed. Information is included on preparation, production of powder products, nuclear properties, physical properties, mechanical properties, chemical properties, radiation effects, and toxicity. (J.R.D.)

32705 PREPARATION OF NICKEL–IRON–MOLYBDENUM ALLOYS. Semenov, G. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 717-19(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 23-6(Sep 1970).

Results are presented of experiments on the preparation of sintered NIMO-30 (similar to Hastelloy B) and NIMO-20 (similar to Hastelloy A) alloy blanks, in which different starting powders and compaction pressures were employed. It was found that the optimum compaction pressure is 4 tons/cm^2; higher pressures give rise to cracking and layering. The highest density is exhibited by specimens pressed from powders prepared by the reduction of an oxide mixture in hydrogen at a temperature of 900°C. The reason for this is that the particles of such powder consist essentially of a solid solution, whose ductility is higher than that of a chemical compound. After sintering, specimens prepared from powders reduced under different conditions exhibit substantial differences in density and volume shrinkage. The highest density is possessed by specimens pressed from powders reduced from a mixture of oxides at 750°C (600°C for NIMO-20 alloy). This may be ascribed to the high activity of particles of such powders (crystal lattice defectiveness, small size, and existence of several phases). With rise in temperature, the activity diminishes, as a result of which sintered specimens of lower density are obtained. (auth)

32706 HIGH PRESSURE BONDING WITHIN THE MOLYBDENUM–COPPER AND CHROMIUM–COPPER ALLOY SYSTEMS. Winchell II, Vern Harry. Denver; Univ. of Denver (1970). 112p. University Microfilms Order No. 71-6038.

Thesis.

Apparent anomalies in metallic alloy behavior were investigated. The object of the work centered on the use of both static and dynamic high pressure environments to achieve bonding in the molybdenum-copper and chromium-copper immiscible binary alloy systems and to relate the results to alloy theory. Bonding was observed in these systems under pressure. Theories stressing the importance of the electronic structure for the alloying elements were used to account for these experimental results. A simplified energy relationship between radius, valence, and coordination number was formulated. Through a proper utilization of these quantities, the bond energy was related directly to a potential energy expression. With this approach, the relationship between the electronic structure of atoms in metals and alloys and the crystal structures of these substances can be more clearly understood. Explosive welding has been developed as a tool for producing high pressure phases. Experimental data for the solidification rate of explosively formed melt zones using the Al – $CuAl_2$ eutectic was analyzed in terms of the interlamellar spacing. Predictions from this analysis were in good agreement with the observed thickness of the high pressure Cr – Cu phase produced by explosive welding. Dynamic high pressure experiments have and will continue to contribute much to a better understanding of the kinetics of the nucleation and growth processes. (Diss. Abstr. Int., B)

32707 DEFORMATION MECHANISM OF POLYCRYSTALLINE AND MONOCRYSTALLINE HIGH PURITY VANADIUM AT LOW TEMPERATURES. Wang, Chun Tsin. Corvallis, Oreg.; Oregon State Univ. (1971). 114p. University Microfilms Order No. 71-6789.

Thesis.

High purity vanadium, both in the polycrystalline and monocrystalline form, was strained in tension in order to study the controlling deformation mechanism at temperatures between 77 and 293°K. The temperature and strain rate dependence of the flow stress for two grades of material, 99.99 and 99.93%, was evaluated using temperature change and strain rate change procedures. An abrupt change of yield and flow stresses, strain rate sensitivity, activation enthalpy, and volume at approximately 200°K indicates that a change of rate controlling mechanism occurs at this temperature. It was found that at temperatures below 200°K, the activation enthalpy is less than 1 eV. and the activation volume is less than 30 b^3. A high strain hardening rate in the early stages of straining and an orientation dependence of flow stress were also noticed. Among all possible controlling activation processes, the pseudo-Peierls mechanism, i.e., the slightly dissociated screw dislocation model, agrees best with the observations. In the temperature range from 200 to 293°K, the yield and flow stresses of vanadium were remarkably affected by the level of impurity content. On the basis of this observation, the controlling process in this temperature range is most probably the interaction between dislocations and impurities. Mechanical twins were formed on single crystals at 77 and 120°K; twins occur on {211} planes. Slip lines could not in general be identified, but were noted in one test. The slip plane determined on a single crystal with ⟨110⟩ axis deformed at 160°K was {211}. Single crystals generally showed a chisel edge type of ductile fracture. (Diss. Abstr. Int., B)

32708 MEASUREMENT OF THE THERMAL CONDUCTIVITY OF TUNGSTEN AT HIGH TEMPERATURES USING THE TWO-BRIDGE METHOD. Vermogradskii, V. A.; Chekhovskoi, V. Ya. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 741-4(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 784-8(Jul-Aug 1970).

To determine the coefficient of thermal conductivity on wire samples, two measuring bridge circuits are used, resulting in increased measurement accuracy. The results of measuring the thermal conductivity of tungsten in the temperature range 1300 to 2500°K are cited, and the data are generalized to the high-temperature thermal conductivity of tungsten. (auth)

32709 HALL EFFECT IN THIN TITANIUM, NIOBIUM, TANTALUM, AND PALLADIUM LAYERS CONTAINING INTERSTITIAL HYDROGEN. Bastl, Z. (Inst. of Physical Chemistry, Prague). Collect. Czech. Chem. Commun.; 36: No. 3, 1172-80(Mar 1971).

Results of the measurements of the Hall coefficient changes in thin titanium, niobium, tantalum, and palladium layers during the hydrogen sorption by these metals are presented. Results are discussed on the basis of the phenomenological model of two overlapping bands. In order to achieve a qualitative agreement of predicted and experimentally found changes, it is necessary to assume that hydrogen in the form of protons is present in the metal. The results show that the rigid-band model may be used in the first approximation to explain the Hall-coefficient changes in titanium–hydrogen and niobium–hydrogen systems. On the basis of the measured data, no conclusion can be drawn as to the applicability of this model to the palladium–hydrogen system. (auth)

32710 SOME PHYSICAL PROPERTIES OF VANADIUM. Voronin, L. K.; Merkul'ev, A. N.; Neimark, B. E. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 737-40(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 780-3(Jul-Aug 1970).

The results of an experimental investigation into the thermal conductivity, specific electrical conductivity, Lorentz number, and monochromatic ($\lambda_{eff} = 0.66\ \mu$) and integral hemispherical emissivities of vanadium at 293 to 1700°K are presented. (auth)

32711 EMISSIVITY, THERMAL CONDUCTIVITY, AND ELECTRICAL CONDUCTIVITY OF REMELTED ZIRCONIUM AT HIGH TEMPERATURES. Peletskii, V. E.; Druzhinin, V. P.; Sobol, Ya. G. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 732-6(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 774-9(Jul-Aug 1970).

The integral hemispherical emissivity, the thermal conductivity, and the electrical resistivity of zirconium obtained by vacuum electron-beam melting were studied at 1200 to 2000°K. The emissivity increased from 0.208 at 1200°K to 0.275 at 2000°K. The thermal conductivity also increased from 28.8 W/m · deg at 1300°K to 33.2 W/m · deg at 1700°K. This increase was attributed to the electron component of the thermal conductivity. Measurements of specific electrical resistance carried out over a wide temperature range indicated the temperature of the polymorphic $\alpha \rightarrow \beta$ transformation (1148 ± 5°K) of zirconium. These results are compared with those of other authors and also with computed estimates of certain properties. (auth)

32712 DIFFUSION OF HELIUM IN SILVER AND STAINLESS STEEL. Garside, David Hepworth. Brighton, Eng.: Univ. of Sussex (1971). 183p. (AERE/EMR/PR-1914).

Thesis.

Measurements by mass spectrometry are described of the amount of helium evolved from silver foils which had previously been loaded by irradiation with α-particles. The isothermal anneals were carried out on polycrystalline samples containing uniform helium concentrations in the range 10^{-2} at. % to 10^{-6} at. % at temperatures between 500°C to the melting point. The results indicate that at all the concentrations and temperatures considered, helium can be trapped in silver, and that the amount of helium trapped decreases with the initial concentration. The results obtained from samples containing ~10^{-2} at. % ^{4}He show large discrepancies and a strong dependence on the initial helium concentration. The diffusion coefficient calculated at each temperature tends to a constant value at low concentration, and Arrhenius plots of values of the diffusion coefficient in samples containing low helium concentrations, in which the effects of trapping are minimised, show a discontinuity in the slope at ~665°C. The diffusion coefficient is depressed above this temperature. Mea-

surements made on similar silver samples during linear temperature rise anneals also show that the release of helium is inhibited above this temperature. Below ~665°C the diffusion coefficient is described by $D = (1.7 \pm 0.5)\ 10^{-2}\ e^{-(40.3 \pm 1.8)10^3/RT}$ for samples containing both 10^{-4} at. % ^{4}He and 10^{-6} at. % ^{4}He. The activation energy given by this equation strongly suggests that helium diffuses by a vacancy mechanism. At anneal temperatures above ~665°C, the apparent diffusion coefficient of helium in samples initially containing ~10^{-14} at. % ^{4}He is described by $D = (5.0 \pm 1.0)\ 10^{-10}\ e^{-(7.7 \pm 0.4)10^3/RT}$ and in samples initially containing 10^{-6} at. % ^{4}He, is described by $D = (2.0 \pm 0.5)\ 10^{-8}\ e^{-(14.6 \pm 1.0)10^3/RT}$. The results are consistent with a proposal that at the lower anneal temperatures, the grain boundaries act as easy paths for the diffusion of helium, but that at the higher temperatures, the decrease in the apparent diffusion coefficient is caused by the increased trapping of helium in clusters on the grain boundaries. Measurements show that the gas release from cold worked silver samples is enhanced, and therefore the dislocations introduced by the cold work act as easy paths for helium diffusion. Measurements made on samples which were damaged by proton bombardment after being loaded with helium show that the extra damage introduced does not affect the gas release behavior in any consistent manner. Measurements were also made of the diffusion coefficient of helium in stainless steel samples which initially contained ~10^{-3} at. % ^{4}He. Between 800°C and 1,000°C the diffusion coefficient is described by $D = (2.0 \pm 0.9)\ 10^{-4}\ e^{-(50.0 \pm 2.0)10^3/RT}$. The measurements indicate that helium trapping occurs more strongly in stainless steel than in silver. (auth) (UK)

32713 SPECIFICS OF THE MECHANISM OF PLASTIC DEFORMATION OF NIOBIUM. Mil'man, Yu. V.; Trefilov, V. I.; Udovenko, A. A. Probl. Prochnosti; No. 12, 45-50(Dec 1970). (In Russian).

The change in the dislocation structure and mechanical properties of polycrystalline niobium resulting from plastic deformation and annealing was studied. The differences in the mechanism of plastic deformation of niobium from that of molybdenum and other body centered cubic metals in group VIA are related to the decreased rigidity (directivity) of the interatomic bond and the increased value of activity volume V in niobium. (JPRS)

32714 INFLUENCE OF TECHNOLOGICAL FACTORS ON MECHANICAL PROPERTIES OF MOLYBDENUM ALLOYS AT LOW TEMPERATURES. Novikov, N. V.; Voytenko, A. F.; Voynitskii, A. G.; Ovsepyan, E. S.; Nekrasova, Z. P. Probl. Prochnosti; No. 12, 69-71(Dec 1970). (In Russian).

The elasticity, plasticity, and strength characteristics of cast molybdenum alloy (0.1% Zr, 0.15% Ti, less than 0.6% W) are presented in the temperature interval between −196 and +20°C. The effect of the structural state on the strength and plasticity of the alloy with decreasing temperature was noted. The influence of peening on the mechanical properties of this alloy at low temperatures is demonstrated. (JPRS)

32715 STUDY OF MECHANICAL CHARACTERISTICS OF HOT PRESSED TUNGSTEN–COPPER PSEUDO-ALLOYS. Karpinos, D. M.; Kravchenko, A. A.; Pilipovskii, Yu. Ya.; (and others). Probl. Prochnosti; No. 12, 64-8(Dec 1970). (In Russian).

Studies were made of the mechanical characteristics of hot-pressed tungsten–copper pseudoalloys and their dependence on the density of the tungsten framework containing the lower-melting component and the time of isothermal holding at the pressing temperature. It is demonstrated that the strength, plasticity, and impact toughness increase with increasing density of the refractory framework and holding time in the 1900 to 2200°C temperature interval during pressing. The hardness and strength in compression depend primarily on the density of the framework and the degree of filling of the pores with copper. (JPRS)

32716 ABSORPTION KINETICS OF NITROGEN + TANTALUM SYSTEM. Yamazaki, Hisashi (Tokyo Metropolitan Univ.). Jap. J. Appl. Phys.; 10: 409-15(Apr 1971).

The dependence of the absorption rate on temperature is studied for a single crystal tantalum wire, and is compared with those for polycrystal wires and ribbons. Two processes of absorption of nitrogen in tantalum are found. In the first process absorption occurs at boundaries of crystal grains and is observed for polycrystal ribbons with surface of the (311) planes; the activation energy of absorption is 1.9 eV/2-atoms. The second process is observed for crystallized or sufficiently flashed wires. In this process atoms chemisorbed on the surface are directly absorbed into the bulk at their absorption sites; the activation energy of absorption is 4.0 eV/2-atoms, which is larger than that of diffusion of nitrogen in tantalum. (auth)

32717 PHYSICAL PROPERTIES OF HOT-PRESSED TUNGSTEN–COPPER PSEUDO-ALLOY. Karpinos, D. M.; Kondrat'ev, Yu. V.; Klimenko, V. S.; (and others) (Kiev Inst of Problems in Studies of Solids). Inzh.-Fiz. Zh.; 20: 96-9(Jan 1971). (In Russian).

A number of physical properties of hot-pressed pseudo-alloy within the temperature range of thermal conductivity from 370 to 2200°, electric conductivity from 300 to 1970°, thermal expansion at 300 to 870° and 1970 to 2200°K were measured. Decreasing conductivity characteristics within the above temperature range were observed. Specific change of thermal expansion coefficient at high temperatures was noted. The influence of copper on physical properties of the composition was discussed. Within temperatures from 1800 to 2200°K intensive volatility of copper from samples was observed. (auth)

32718 SOLID SOLUTION STRENGTHENING IN NIOBIUM SINGLE CRYSTALS. Jax, Peter (Univ., Goettingen, Ger.). Z. Metallk.; 62: 279-91(Apr 1971). (In German).

The critical shear stress τ_0 in solid solutions of Nb with additions of Mo, W, and Pd was determined for temperatures ranging from 295 to 1050°K. The measurements were carried out on single crystals containing different amounts of interstitial foreign atoms. In the case of the Nb–Pd system it is not possible to judge from the experimental results whether τ_0 varies in proportion to $c^{\frac{1}{2}}$ or c. The effect of solid solution strengthening in the plateau region can be explained with an elastic interaction of dislocations with substitutional foreign atoms. For temperatures above approximately 550°K the temperature and concentration dependence of τ_0 change considerably with increasing content of interstitial impurities. (auth)

32719 DENSITY OF MOBILE DISLOCATIONS DURING STRESS RELAXATION. Bocek, Michael; Schneider, Walter (Kernforschungszentrum, Karlsruhe, Ger.). Z. Metallk.; 62: 302-4(Apr 1971).

Experiments performed with polycrystalline vanadium samples showed that in contrast to a strain rate-change test the density of mobile dislocations during stress relaxation remains constant. The decrease of deformation rate during stress relaxation is in this case controlled through the activation energy by the stress dependent waiting time of mobile dislocations at the obstacles. (auth)

32720 THERMODYNAMIC PROPERTIES OF Pr–Zn ALLOYS. Chiotti, P.; Mason, J. T. (Ames Lab., Iowa). Met. Trans.; 2: 967-73(Apr 1971).

Zinc vapor pressure data obtained by the dewpoint method were employed in calculating the thermodynamic properties of both liquid alloys and solid compounds. The liquid alloy data were fitted to the relation $\Delta \overline{F}^{ex}_{Zn} = N^2_{Pr}[a + bN_{Zn} + cN^2_{Zn} + dN^3_{Zn} + eN^4_{Zn} + fN^5_{Zn}]$ from which the relation

$$\Delta F^{ex}_{Pr} = N^2_{Zn}\left[a + b\left(N_{Zn} - \frac{1}{2}\right) + cN_{Zn}\left(N_{Zn} - \frac{2}{3}\right) + dN^2_{Zn}\left(N_{Zn} - \frac{3}{4}\right) + eN^3_{Zn}\left(N_{Zn} - \frac{4}{5}\right) + fN^4_{Zn}\left(N_{Zn} - \frac{5}{6}\right)\right]$$

was obtained by integration of the Gibbs–Duhem equation. In these relations N is the atom fraction, a = −16,250 + 4.00 T, b = −30,650 + 11.50 T, c = 15,290 − 30.17 T, d = −153,000 + 70.0 T, e = 9000 + 20.0 T, f = 9000 + 20.0 T. The standard free energy changes for the reactions $Pr(\alpha) + xZn(l) \rightarrow PrZn_x(s)$ are given. (auth)

32721 LOW TEMPERATURE STRENGTHENING IN NIOBIUM–HYDROGEN SINGLE CRYSTALS. Ravi, K. W.; Gibala, R. (Case Western Reserve Univ., Cleveland). Contract AT(11-1)-1676. Met. Trans.; 2: 1219-25(Apr 1971).

The mechanical behavior of high purity niobium and niobium-hydrogen single crystals at temperatures in the range 77 to 380°K was investigated. Thermally activated hardening by hydrogen in solution is appreciable at temperatures ≲150°K. However, hydride precipitation occurs at these temperatures, can be strain-induced during mechanical testing, and accounts for the largest part of the decrease in ductility in alloys with up to 720 at. ppM of hydrogen. The influence of hydrogen additions and the effects of purification on the low temperature flow stress of niobium demonstrate the large influence of interstitial solutes on the strength of bcc materials at low temperatures. (auth)

32722 MICROFLOW IN NIOBIUM ALLOY CRYSTALS. Wilson, F. Graham; Tethtsoonian, E. (Univ. of British Columbia, Vancouver). Met. Trans.; 2: 1183-8(Apr 1971).

Single crystals of dilute Nb-Mo and Nb-Ta alloys were deformed in tension over a range of temperatures and strain sensitivities. At macrostrains, a large parabolic hardening is observed in Nb–Mo alloys at 295°K; a similar though much smaller effect is observed with Nb-Ta alloys in spite of the absence of an atomic size difference. Alloying does not appear to affect either the nature of the

slip lines or the operative slip system. The transition from microyielding to macroflow was studied in prestrained crystals using a dynamic microstrain technique. In contradiction to previous results, alloying is found to affect microflow in the same way as macroflow. Solute is believed to affect the mobility of dislocations by a long range elastic interaction; solute has no significant effect on dislocation multiplication. At low temperatures, a solution-softening effect is observed during microflow of Nb-Ta alloys, as it is at macroflow. (auth)

32723 STANDARD SPECIFICATION FOR TANTALUM INGOTS AND FLAT MILL PRODUCTS. ASTM B 364-70. Philadelphia; American Society for Testing and Materials (1970). 3p. Available from American Society for Testing and Materials, Philadelphia.

This specification covers unalloyed tantalum in several grades and forms. The grades consist of powder metallurgy, arc cast, and electron-beam cast and the forms include ingot, bar, plate, sheet, strip, and foil. (auth)

Structure and Phase Studies

Refer also to abstract 33457.

32724 (RFP-1609) ISOTHERMAL TRANSFORMATIONS OF URANIUM-13 ATOMIC PERCENT NIOBIUM. Jackson, Ross J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 9 Apr 1971. Contract AT(29-1)-1106. 7p. Dep. NTIS.

The isothermal-transformation behavior of the gamma phase of the uranium-13 at. % niobium alloy was determined for the temperature range between 23 and 640°C. Optical and electron metallography, hardness, and x-ray diffraction techniques were used to construct a time-temperature-transformation diagram. The diagram discloses two overlapping C-curves. The upper C-curve corresponds to a lamellar precipitation of alpha plus a niobium-deficient gamma-phase which gradually enriches in niobium to form the equilibrium γ_2 structure. The lower C-curve is a general precipitation of alpha phase on dislocation. (auth)

32725 ENTHALPY OF FORMATION OF THE NITROGEN SOLID SOLUTION IN α-ZIRCONIUM AND OF ZIRCONIUM NITRIDE IN THEIR HOMOGENEITY REGIONS. Gal'braikh, E. I.; Kulik, O. P.; Kuznetsov, A. A.; Lyutaya, M. D.; Morozova, M. P. (Leningrad State Univ. Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 748-51(Sep 1970.

Translated from Porosh. Met., Akad, Nauk Ukr. SSR; No. 9, 62-6(Sep 1970).

A study was made of the enthalpy of formation of nitrogen solid solutions in zirconium and of zirconium nitride within their homogeneity regions. It was established that the enthalpy of formation changes linearly within the homogeneity region of each phase. The fact that nitrogen content within the homogeneity region of each phase affects the rate of change in enthalpy of formation is ascribed to differences in the character of chemical bonding. This manifests itself also in differences in the chemical properties of the nitrogen solid solution in zirconium and zirconium nitride in their homogeneity regions. (auth)

32726 STRUCTURES OF TERNARY RARE EARTH COMPOUNDS. Parthe, Erwin (Univ. of Pennsylvania, Philadelphia). pp 61-79 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

From the limited amount of experimental data available, it appears that the structure types of the ternary rare earth compounds are nearly always closely related to binary structure types. Line compounds with partial disorder of the alloying partners may be distinguished from point compounds with ordered derivatives of binary structures. Line compounds have broad homogeneity ranges and the occurrence of a particular structure type can be associated with a particular valence electron range. Point compounds have no homogeneity range and do not depend on valence electron concentration. The construction elements important for the middle concentration range are the trigonal prism and the cube. (auth) (France)

32727 ALLOY THEORY OF THE RARE-EARTH METALS. Gschneidner, K. A. (Iowa State Univ., Ames). pp 81-7 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The results of recent studies of the alloy theory of the rare-earth metals are discussed. These include the influence of the 4f contribution on the bonding in the crystal structure of the metals and their compounds, the electronic dependence of the entropy of fcc (or hcp) ⇌ bcc transformation in metals, the factors which influence the formation of solid-solution alloys, and the interrelations between the free energy of formation, the melting point, and lattice parameters of lanthanide compounds. (auth) (France)

32728 RARE-EARTH COBALT INTERMETALLIC COMPOUNDS. Buschow, K. H. J. (Philips Gloeilampenfabrieken, Eindhoven, Netherlands). pp 101-12 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

A number of rare earth–cobalt systems were investigated by x-ray diffraction, thermal analysis, and metallography. Particular features of these binary systems are discussed. The number of stable compounds observed in the rare earth–cobalt systems varies from six to eight. The structures of most of the compounds are size-dependent: for the trivalent rare earth elements, only the compound R_3Co exists throughout the whole series and undergoes no change of structure. The other compounds, R_4Co_3, RCo_2, RCo_3, R_2Co_7, RCo_5, and R_2Co_{17}, either become unstable with respect to the adjacent phases or change their structure or stoichiometry when the radius ratio is varied. For the series R_2Co_7, and R_2Co_{17}, two types of structures were obtained by a variation in the heat treatment. Most of the structures observed for the Co-rich compounds were found to be insensitive to changes in the valence electron concentration. (auth) (France)

32729 CRYSTALLINE STRUCTURES OF Tb-Ni. Lemaire, Remy; Paccard, Dominique (CNRS, Grenoble, France. CEA, Grenoble, France). pp 113-23 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The crystalline structures of the compounds TbNi are of two types depending upon the heat treatment. The first type of compound, obtained when the liquid is quenched, crystallizes in the Pnma space group with a = 21.09 Å, b = 4.22 Å, c = 5.45 Å. The second type of compound, obtained when the compound is annealed to 950°C, crystallizes in the $P2_1/m$ space group with a = 21.26 Å, b = 4.21 Å, c = 5.45 Å, β = 97°25'. As with FeB and CrB type structures, the two new structures contain a common structural unit, the trigonal prism, which is stacked differently to form each structure. On this basis, a set of transformation equations relating the lattice constants of both structure types is derived. (auth) (France)

32730 INTERMETALLIC ZINC–RARE EARTH COMPOUNDS WITH RATIOS OF APPROXIMATELY 1/4. Bruzzone, G.; Fornasini, M. L.; Merlo, F. pp 125-33 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The occurrence of intermetallic phases with the composition M_1X_4 (M = rare earth element) was investigated in the case of X = zinc. The experimental results show the existence of the orthorhombic $LaZn_4$ phase. The crystal structure of this compound appears to be related to the $D1_3$ type of structure ($BaAl_4$). For the other rare earth metals, the 1:4 composition does not correspond to a homogeneous phase and the M_3Zn_{11} compounds are stable. The crystal structures of Ce_3Zn_{11}, Pr_3Zn_{11}, Nd_3Zn_{11}, Sm_3Zn_{11}, Y_3Zn_{11}, and Yb_3Zn_{11} whose existences have already been established were determined, together with the newly found Gd_3Zn_{11}, Tb_3Zn_{11}, and Dy_3Zn_{11} phases. The relations between the crystal structures of the M_3Zn_{11}, MZn_3, and MZn_4 phases are examined. (auth) (France)

32731 CRYSTALLINE STRUCTURE OF RE_2Tl COMPOUNDS. Palenzona, Andrea; Franceschi, Enrico (Univ., Genoa). pp 135-41 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The rare earth–thallium compounds containing the largest quantities of rare earths were examined and the structure of phases with 2:1 compositions with Pr, Nd, Sm, Gd, and Tb subsequently determined. The structural relation between these compounds and those of the 5:3 type such as Mn_5Si_3 is examined. (France)

32732 STUDY OF THE SAMARIUM-TYPE STRUCTURE IN BINARY INTRA RARE EARTH ALLOYS. Lundin, C. E. (Denver Research Inst.). pp 151-7 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

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From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.I).

Representative systems were selected and subjected to metallographic x-ray diffraction, thermal analysis, resistivity, dilatometric, hardness, and electron-beam microprobe studies. The studies indicated that the samarium-type structure is not a first-order phase in these systems, but a change in stacking sequence compared to its elemental components and their adjacent solid solutions. All the systems studied were found to exhibit complete solid solubility in the hexagonal close-packed structure and in the high-temperature, body-centered-cubic structure. The alloyed samarium-type structure was found to have the same type of microstructure, atomic stacking sequence, and lattice parameters as pure samarium metal. The criteria of formation evolved for the samarium-type structure is that a light rare earth should be alloyed with a heavy rare earth. The morphology indicated that a strain-induced structure occurs which is characteristic of a martensite-type transformation. This structure consists of angular grains with extremely fine twinning. (auth) (France)

32733 BINARY PHASE DIAGRAMS OF YTTERBIUM WITH Cu, Ag, AND Au. Iandelli, A.; Palenzona, A. (Univ., Genoa). pp 159-64 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.I).

The binary phase diagrams of ytterbium with the IB-group elements Cu, Ag, Au were studied by differential thermal, micrographic, and x-ray analysis. In these alloy systems, intermetallic phases are found, in which Yb behaves either as a divalent (alkaline-earth-like) element or as a trivalent rare earth. (auth) (France)

32734 STUDY OF THE TIN-SAMARIUM SYSTEM. Percheron, Annick (CNRS, Bellevue, France). pp 165-72 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.I).

The Sm-Sn binary phase diagram was determined by differential thermal analysis, metallographic, and x-ray methods. The solid solubility is very small for the pure materials. The addition of Sn to Sm lowers the $\alpha-\beta$ transformation temperature. Eutectic reactions occur at 906°C(11 at. % Sn), at 1080°C(67 at. % Sn) and at 229°C(99.8 at. % Sn). The intermetallic compounds Sm_5Sn_3 and $SmSn_3$ melt congruently at 1505 and 1090°C respectively. Sm_4Sn_3, Sm_5Sn_4, $Sm_{11}Sn_{10}$, Sm_2Sn_3 melt peritectically at 1440, 1420, 1170, 1105°C respectively. The crystal structures and lattice parameters were determined. (France)

32735 ORDERING WITH PERIODIC ANTIPHASE DOMAINS IN THE α-SOLID-SOLUTIONS OF SILVER-LITHIUM. Migge, H.; Andresen, H. (Hahn-Meitner Inst., Berlin). Scr. Met.; 5: 175-9(Mar 1971).

Results of investigations are described in which it was found that alloys with compositions approximately Ag_3Li periodic antiphase structures of the type aleatory periodic are formed. Reflections in the electron diffraction patterns were observed which show symmetrical splitting of either of the {100} and {110} superlative positions. It is noted that splitting of superlattice reflections is well known as an indicator of periodic antiphase structures. (J.R.D.)

32736 THERMAL EXPANSIONS OF THULIUM AND LUTETIUM, 90 TO 300°K. Singh, Sohan; Khanduri, N. C.; Tsang, Tung (Howard Univ., Washington, D. C.). Scr. Met.; 5: 167-73(Mar 1971).

The lattice parameters a and c for the hexagonal rare earth metals Tm and Lu were measured in the temperature range 90 to 300°K. The results are in fair agreement with the high temperature values. Anomalous expansions for a-axis of Tm were found. The Gruneisen parameters γ for Tm and Lu thus obtained near room temperature were 0.65 and 0.73 respectively, and are consistent with the experimental values (0.3 to 0.9) of other rare earth metals. (auth)

32737 EVIDENCE FOR DISSOCIATION OF $\frac{1}{2}$ (111) DISLOCATIONS ON [110] IN Mo AND Fe AT 77 K. Sleeswyk, A. W. (Univ., Groningen, Netherlands). Scr. Met.; 5: 217-21(Mar 1971).

Results of dislocation mobility experiments on Mo and Fe indicate that at 193°K and higher temperatures the expression σ vs. $kT\ln(v_c/v)$ for dislocation motion is valid. The activation energy for slip on {110} in Fe and Mo at 77°K as a function of σ is half that at 193°K and higher temperatures; a plausible explanation of this finding is the dissociation of the $\frac{1}{2}\langle 111\rangle$ dislocation in two $\frac{1}{4}\langle 111\rangle$ partials. The well-known low-temperature transition in Fe from "wavy" to "lamellar" slip appearance is adequately explained by this effect. These effects may be influenced by the addition of alloying elements that change the stacking fault energy on {110}. From the available data it appears that addition of Ni to Fe increases the stacking fault energy, whereas addition of Si has the opposite effect. (auth)

32738 SPLITTING OF BORDONI PEAK INTO EDGE AND SCREW COMPONENTS IN BCC STRUCTURE. Escaig, B. (Faculte des Sciences, Lille-Cusla, France). Scr. Met.; 5: 199-206 (Mar 1971).

A review of present understanding of friction in bcc structures is presented. Results of experiments are also presented which show that the existence of distinct edge and screw Bordoni peak explains qualitatively most of the behavior of P_α and P_β peaks found in polycrystalline Mo and Nb samples slightly deformed. Similar damping spectra seems to hold also in vanadium and tantalum, but these metals have not yet been studied so thoroughly. However, a definite conclusion has to wait for results on very pure single crystals (less than 100 ppM impurity) and at low frequency to avoid impurity migrations to dislocations. If such an existence can be firmly established, that kind of internal friction experiment provides an excellent way of studying microdeformation in bcc metals, edge and screw mobility, and their relation to impurities. (J.R.D.)

32739 RARE-EARTH-COBALT INTERMETALLIC COMPOUNDS. Buschow, K. H. J. Philips Res. Rep.; 26: 49-64 (FEB 1971)(+

A number of rare-earth-cobalt systems were investigated by x-ray diffraction, thermal analysis, and metallography. Particular features of these binary systems and those already known in the literature are discussed. The number of stable compounds observed in the rare-earth-cobalt systems varies from six to eight. The structures of most of the compounds are size-dependent. For the trivalent rare-earth elements, only the compound R_3Co exists throughout the whole series and undergoes no change of structure. The other compounds, among which R_4Co_3, RCo_2, RCo_3, R_2Co_7, RCo_5, and R_2Co_{17}, either become unstable with respect to the adjacent phases or change their structure or stoichiometry when the radius ratio is varied. For the series R_2Co_7 and R_2Co_{17} two types of structures were obtained by a modification of the heat treatment. Most of the structures observed for the Co-rich compounds were found to be fairly insensitive to changes in the valence-electron concentration. (auth)

32740 LOW-ENERGY-ELECTRON-DIFFRACTION STUDY OF O_2 AND H_2S ADSORPTION ON Mo (100). Tabor, D.; Wilson, J. M. (Cambridge Univ., Eng.). J. Cryst. Growth; 9: 60-7 (May 1971).

From first international conference on crystal growth and epitaxy from the vapour phase; Zurich, Switzerland (23 Sep 1970). See CONF-700957.

The adsorption of O_2 and H_2S on the (100) face of a single crystal of molybdenum is reported. Using Auger spectroscopy it is found that the major impurities on this face are sulfur, carbon, and oxygen. The carbon and oxygen peaks can be reduced to the limit of detectability, and the sulfur peaks could be reduced substantially by heating the crystal to 1500°C in 1×10^{-6} torr of oxygen for six hours. With the specimen between 750 and 1000°C, oxygen exposures ranging from 6 L to 900 L give rise to a diffraction pattern composed of two sets of diffuse streaks. An analysis of the diffraction features suggests that they derive from {110} and {112} type planes formed by thermal faceting in oxygen. The experiments also suggest that at lower temperatures three-dimensional oxide nuclei are formed. The interaction of H_2S with the crystal could be explained by adsorption on sites. No apparent three-dimensional sulfide is formed under the conditions of the experiment. (auth)

32741 STRUCTURE OF VAPOR-DEPOSITED MOLYBDENUM AND TUNGSTEN SINGLE CRYSTALS. Reitzenstein, W.; Weise, G. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). J. Cryst. Growth; 9: 228-37(May 1971). (In German).

From first international conference on crystal growth and epitaxy from the vapour phase; Zurich, Switzerland (23 Sep 1970). See CONF-700957.

The morphology and crystal perfection of single crystals of molybdenum and tungsten obtained by vapor deposition using the thermal decomposition of halides depend on the supersaturation. The crystals were examined by metallographic investigations and x rays in order to determine position, extension, and kind of the disturbances. These investigations show that at lower supersaturations with {110} as the equilibrium form face, disturbances appear regularly in layers and within defined

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crystallographic positions, which depend on the growth direction in different {110} planes. In most cases it was found that the disturbed layer appears in the mirror plane of the planes containing the growth steps. (auth)

32742 ELECTRON MICROSCOPE IMAGE CONTRAST FROM DISLOCATION LOOPS. Bullough, R.; Maher, D. M.; Perrin, R. C. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Status Solidi (b); 43: No. 2, 689-706(1 Feb 1971).

Experimental electron microscope images of dislocation loops in molybdenum have been compared to theoretical loop images displayed in the form of computer-simulated micrographs. The exact displacement field around a circular edge dislocation loop has been calculated using isotropic elasticity theory; this displacement field together with the two-beam dynamical theory of electron diffraction contrast have been used to compute image intensities. Specific results are given for loops of radius ≈250 and ≈25 Å. Their contrast has been studied over a narrow range of the numerous variables which are known to influence image features. It has been found that the general topographical character of certain prominent experimental images is qualitatively accounted for by the simple "elastic" defect model with the two-beam theory of electron diffraction. (auth)

32743 EFFECTS OF THERMAL CYCLING OF TUNGSTEN AND MOLYBDENUM SINGLE CRYSTALS. Savitskii, E. M.; Burkhanov, G. S.; Raskatov, N. N.; Tetyueva, T. V. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 195: 329-32(11 Nov 1970). (In Russian).

Thermal cycling induces irreversible structural changes in metals. The effect of thermal fatigue which has been investigated primarily on low-melting metals was studied on the refractory tungsten and molybdenum single crystals. The behavior of carbon which was considered especially harmful as it leads to the embrittlement of these metals was specifically examined. The single crystals examined contained 0.01 to 0.02 wt % carbon, 0.0001 wt % of each oxygen and nitrogen, and 0.0001 wt % of hydrogen. The specimens were subjected to high-temperature thermal cycling in a helium atmosphere: the tungsten at 2500 and 1000°C and the molybdenum at 1600 and 400°C. It was found that the thermal cycling was accompanied by a strong decarbonization and breakup of carbide occlusions, accompanied by multiplication and motion of dislocations under the influence of thermal stresses. Polygonization, i.e., formation of new subgrains, was also observed. The structural changes affect the physical and mechanical properties, resulting in the decrease of electrical resistivity and microhardness, followed first by an increase of plasticity and ultimately by embrittlement. (TTT)

32744 ACTIVATION ENERGIES FOR NORMAL GRAIN GROWTH IN LEAD AND CADMIUM-BASE ALLOY. Simpson, C. J. (Univ. of Toronto); Aust, K. T.; Winegard, W. C. Met. Trans.; 2: 993-7(Apr 1971).

High temperature third and fourth stage grain growth was found to conform to the theoretical rate equation $D^2 - D_0^2 = K(t - t_0)$. The activation energy for fourth stage grain growth was measured and found to be similar to that of grain boundary self-diffusion. The activation energy for third stage grain growth is considerably larger and is comparable to that of volume self-diffusion. (auth)

32745 FOUR STAGES OF GRAIN GROWTH. Simpson, C. J. (Univ. of Toronto); Aust, K. T.; Winegard, W. C. Met. Trans.; 2: 987-91(Apr 1971).

A study of grain growth in dilute cadmium and lead base alloys revealed that there are four stages of grain growth as a function of annealing temperature and solute concentration. One of these stages, which can result in a substantial change in grain size, involves irregular grain growth or secondary recrystallization. (auth)

32746 EFFECT OF HEAT TREATMENTS IN INTERMETALLIC COMPOUND $SmCo_5$. Shibata, Tsugio; Katayama, Toshikazu (Electrotechnical Lab., Tokyo). Jap. J. Appl. Phys.; 10: 510 (Apr 1971).

The relation between magnetic properties and crystal structure of $SmCo_5$ powders which are produced by vibration milling of both as-cast and annealed compounds is reported. The compounds were obtained by arc-melting in pure argon, followed by remelting several times to homogenize them. A portion of the arc-melted compound was annealed at 800°C for 200 hours in an atmosphere of pure argon. X-ray diffraction patterns were obtained for both as-cast and annealed compounds, using FeK_α radiation. Samples for coercive force measurements were made by orienting powders in a field of 16 kOe and compacting them at a pressure of 7 t/cm^2. (auth)

32747 CRYSTALLOGRAPHIC STUDY OF THE TERNARY DIAGRAM La–Er–Se. Guittard, Micheline; Lozac'h, Anne-Marie (Univ., Paris). Bull. Soc. Chim. Fr.; No. 3, 751-4(Mar 1971). (In French).

An x-ray study of solid solutions and intermediate compounds formed in the ternary system La–Er–Se was carried out. Three principal types of solid solution were observed: a tetragonal range in the polyselenide region, along the $La_nEr_{1-n}Se_{1.9}$ line ($0 < n < 0.40$); a homogeneous Th_3P_4-type surface; a NaCl-type solid solution along the LaSe–ErSe line. Two intermediate compounds were identified: $ErLaSe_3$ of unknown structure and monoclinic Y_2S_7-type $LaEr_4Se_7$. The results are applied to the binary systems La–Se and Er–Se. (auth)

32748 SYSTEM Ti–Zr. Chatterji, D. (Purdue Univ., Lafayette, Ind.); Hepworth, M. T.; Hruska, S. J. Met. Trans.; 2: 1271-2(Apr 1971).

Because of considerable discrepancies in phase diagrams found in the literature the Ti-Zr system was reinvestigated following the method used by McQuillan. Reproducible results could not be obtained with the Ti–50 at. % Zr sample, probably because of the long time required for equilibration at each temperature and consequent oxidation of the specimen. The Ti-Zr phase diagram was established from the experimental data. (G.M.C.)

32749 VARIATION OF INTERFACE DISLOCATION NETWORKS WITH LATTICE MISMATCH IN EUTECTIC ALLOYS. Cline, H. E.; Walter, J. L.; Koch, E. F.; Osika, L. M. (General Electric Research and Development Center, Schenectady, N. Y.). Acta Met.; 19: 405-14(May 1971).

Dislocation networks at the interface between phases were studied in directionally solidified eutectics NiAl–Cr and NiAl–Cr(Mo) to determine the effect of lattice parameter mismatch on the spacing and configuration of the interface dislocations. The lattice mismatch was varied by adding different amounts of Mo to the eutectic NiAl–Cr and by quenching NiAl–Cr from temperatures near the melting point to retain the high temperature solid solution and reduced lattice mismatch. The dislocation networks were examined by transmission electron microscopy and the lattice mismatch calculated from the spacing of the dislocations. Lattice parameter mismatch was also measured by x-ray techniques at room temperature and at elevated temperatures to determine the effects of thermal expansion and solubility on the mismatch. In the case of the slowly cooled NiAl–Cr and NiAl–Cr(Mo) alloys, the mismatch calculated from the spacing of the dislocations at room temperature agreed with the measured mismatch at room temperature. In the heated and quenched NiAl–Cr eutectic, the reduced mismatch at elevated temperature was reflected by rotated networks and increased dislocation spacing (compared with the slowly cooled eutectics) at room temperature. When mismatch decreases in the solid, the interface dislocations move from the interface network into the NiAl matrix. When mismatch increases in the solid, stresses deform the matrix and the glide dislocations move from the matrix into the interface to decrease the spacing of the dislocations in the interface networks. (auth)

32750 STUDY OF THE TRANSFORMATION TO THE SAMARIUM-TYPE STRUCTURE IN Gd–Ce ALLOYS. Koch, C. C.; Mardon, P. G.; McHargue, C. J. (Oak Ridge National Lab., Tenn.). Met. Trans.; 2: 1095-1100(Apr 1971).

The nature of the phase transformation to the rhombohedral samarium-type structure was studied in Gd–Ce alloys. The experimental techniques used were electrical resistance measurements, elevated-temperature x-ray diffraction studies, optical metallography, and transmission electron microscopy. Electrical resistance-temperature hysteresis loops were observed in two temperature regions. X-ray studies confirmed that the upper temperature behavior was due to the phase transformation (hcp ⇌ Sm-type or dhcp ⇌ Sm-type). The lower temperature hysteresis loop does not involve a change in crystal symmetry but does coincide with an increased rate in expansion of the a_0 parameter such that the axial ratio becomes essentially constant with temperature. Optical and electron microscopy revealed a morphology of fine parallel bands extending across a grain in a single variant. This is consistent with the transformation plane being the basal plane. (auth)

Radiation Effects

Refer also to abstracts 32863, 33412, 33414, 33426, and 34339.

32751 (HEDL-TME-71-43) IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS. Quarterly Progress Report, November 1970–January 1971. Claudson, T. T. (ed.) (Hanford Engineering Development Lab., Richland, Wash.). Mar 1971. Contract AT(45-1)-2170. 353p. Dep. NTIS.

Research and development on irradiation damage in materials is summarized. Results of testing at Atomics International,

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Argonne National Laboratory, Battelle Memorial Institute, General Electric Company, Hanford Engineering Development Laboratory, Idaho Nuclear Corporation, Naval Research Laboratory, Oak Ridge National Laboratory, and Pacific Northwest Laboratory are reported. (J.R.D.)

32752 (ORNL-4653) HEAVY-SECTION STEEL TECHNOLOGY PROGRAM. Semiannual Progress Report for Period Ending August 31, 1970. (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 65p. Dep. NTIS.

Efforts by engineering, fabrication, and utility groups to assess the in-service structural safety of heavy-section pressure vessels are reported. Information is included on program administration, results of tests on irradiated and unirradiated materials, and results of pressure vessel investigations. (J.R.D.)

32753 VOID FORMATION IN NICKEL DURING HIGH TEMPERATURE PROTON IRRADIATION. Neely, H. H.; Herschbach, K. (Atomics International, Canoga Park, Calif.). Radiat. Eff.; 7: 187-94(Feb 1971).

Pure Ni foils, doped with He from 0 to 28 appM, were irradiated with protons at temperatures in the range 0.3 to 0.6 T_m (T_m = melting point in °K) and void formation was studied. The influence of He doping, irradiation temperature, and alloying were investigated. For constant He content and proton fluence, void number density and swelling are maximum at about 400°C, while the void size increases with temperature. Most voids are octahedral in shape with no sign of truncation. Helium is required to nucleate voids, and lowering the stacking fault energy by alloying suppresses void formation completely. Present results suggest that void nucleation is inhomogeneous. Some implications of these findings are discussed. (auth)

32754 RADIATION ENHANCED RECRYSTALLIZATION IN METALS. Williams, K. R.; Fisher, S. B.; McLauchlin, I. R. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 7: 203-9(Feb 1971).

The use of a high-voltage electron microscope has enabled direct observation of recrystallization in copper and stainless steel foils approximately 1 μ thick. Recrystallization occurs by a similar mechanism in bulk material, but it is possible that the kinetics of the process are modified by the high diffusivity provided by electron damage during observation. In particular the empirical recrystallization equation $X_v = 1 - e^{-Bt^k}$ is obeyed for foils with k having a value of ≈20. This result suggests that bulk recrystallization behavior is taking place. (auth)

32755 ANALYSIS OF REACTOR VESSEL RADIATION EFFECTS SURVEILLANCE PROGRAMS. Steele, L. E.; Serpan, C. Z. Jr. ASTM Special Technical Publication 481. Philadelphia; American Society for Testing and Materials (1970). 275p. $26.00.

Surveillance information and data are presented in six chapters. A separate abstract was prepared for each chapter. (J.R.D.)

For abstracts of individual chapters see: 32756–32761.

32756 BASIS FOR VESSEL SURVEILLANCE. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 17-46(1970).

Methods for assessing radiation effects on reactor structural materials are examined. Information is included on fast fracture of steels, reactor vessel surveillance, steel fracture study results, and AEC research programs. (J.R.D.)

32757 NEUTRON EMBRITTLEMENT OF PRESSURE VESSEL STEELS: A BRIEF REVIEW. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 47-101(1970).

Results of studies conducted to assess the effects of high energy nuclear radiation on the properties of reactor pressure vessel steels are presented. Information is included on factors affecting steel embrittlement, development of low radiation-sensitive steels, and mechanical properties of steels. (J.R.D.)

32758 ARMY REACTOR VESSEL SURVEILLANCE AND VESSEL EXAMINATION. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 103-36(1970).

Surveillance methods used in connection with Army reactor pressure vessels are summarized. Special attention is directed to in-place annealing of the SM-1A reactor vessel and past service testing of the PM-2A reactor vessel. (J.R.D.)

32759 COMMERCIAL REACTOR VESSEL SURVEILLANCE. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 137-206(1970).

Results of commercial reactor vessel surveillance programs are analyzed. Information is included on Dresden I, Yankee, Saxton, Big Rock Point, Elk River, Humbolt Bay, Bonus, Pathfinder, LaCrosse, San Onofre, Brookwood, Indian Point, Palisades, and Turkey Point reactors. (J.R.D.)

32760 NEUTRON DOSIMETRY AND SPECTRUM. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 207-35 (1970).

A description of neutron dosimetry and spectrum analysis techniques necessary for meaningful reactor vessel surveillance is presented. (J.R.D.)

32761 SURVEILLANCE PROGRAMS CRITIQUE AND RECOMMENDATIONS. ASTM (Amer. Soc. Test. Mater.) Spec. Tech. Publ.; No. 481, 237-59(1970).

Conclusions and critiques of results from various reactor pressure vessel surveillance programs are presented. Information is included on Army reactor surveillance, commercial reactor surveillance, assuring adequate surveillance and recommendations. (J.R.D.)

32762 EFFECT OF NEUTRON IRRADIATION DOSES ON THE CHANGE IN SUBSTRUCTURE DURING ANNEALING OF TUNGSTEN SINGLE CRYSTALS. Kravchenko, V. S.; Larikov, L. N.; Plotnikova, N. P. (Inst. of Physics of Metals, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 16: 410-12(Mar 1971). (In Russian).

The change in substructure during the annealing of neutron-irradiated tungsten single crystals was investigated by the method of x-ray-diffraction topography developed by Berg and Barret. It is shown that irradiation at 5×10^{20} neutrons/cm^2 with the subsequent annealing of samples which results in a complete unstrengthening does not cause recrystallization. In the course of annealing, an increase in disorientation of subgrains is observed without their notable growth. The disorientation increases with dose, which may be due to the growing density of defects caused by irradiation. The interaction of the defects with subboundaries during annealing leads to the increase in disorientation between them. (auth)

32763 THERMAL NEUTRON DAMAGE IN CADMIUM. Coltman, R. R. Jr.; Klabunde, C. E.; Redman, J. K.; Southern, A. L. (Oak Ridge National Lab., Tenn.). Radiat. Eff.; 7: 235-62(Feb 1971).

The isochronal annealing of the damage produced by thermal-neutron irradiation of cadmium at 3.6°K was studied for several initial doses varying by a factor of 1000. The recovery results show a strong dependence upon initial dose. This effect, which is not seen to this extent in the fcc metals, cannot be accounted for by an irradiation annealing mechanism. In contrast to the observation of two processes involving long-range defect migration for several fcc metals, only one process at high temperatures is discernable from isochronal annealing of Cd. The presence of another process at low temperatures is clearly established by other means. Irradiation annealing effects observed during the production of damage at high defect concentrations indicate that the spontaneous annihilation volume between the defects of a new capture event and the defects from an earlier event is 80 atomic volumes. Other results suggest that damage production and recovery mechanisms may be associated with the anisotropic nature of the cadmium hexagonal lattice. (auth)

32764 METAL TIPS PRODUCED BY ELECTRON BOMBARDMENT. Drechsler, M.; Prulhiere, J. P. (CNRS, Marseille). Vacuum; 20: 491-4(Nov 1970). (In English and French).

An apparatus is described to transform the end of a tungsten wire in a vacuum into a fine tip by electron bombardment. Curvature radii at the tip apex down to 10^3 X are obtained. The tips are controlled by (1) an optical microscope, (2) an electron microscope, and (3) a field electron microscope. The interpretation of the process of tip sharpening is based on evaporation, surface diffusion and surface energy in the presence of a temperature gradient caused by the electron bombardment. It seems possible to use the method for the production and the regeneration of point cathodes in electron microscopes as well as a field emitter in field emission microscopes. (auth) (UK)

32765 METALLOGRAPHIC REAGENTS: HASTELLOY N. Gray, R. J. (Union Carbide Corp., Oak Ridge, Tenn.). Microstructures; 2: No. 2, 26(Feb-Mar 1971).

The composition of an etching solution for Hastelloy N is given. A photomicrograph showing a specimen etched using the solution is included. The etchant has 5 parts HCl and 1 part HNO_3, or 3 parts HCl, 1 part HNO_3, and 4 parts glycerol for swabbing. (J.R.D.)

Ceramics and Cermets

Refer also to abstracts 32637, 32640, and 32642.

32766 ELECTRON MICROSCOPY, 1968. VOLUME I. Pre-Congress Abstracts of Papers Presented at the Fourth European Regional Conference Held in Rome, September 1–7, 1968. Boc-

ciarelli, Daria Steve (ed.). Rome: Tipografia Poliglotta Vaticana (1968). 648p. (In several languages). (CONF-680942-(Vol.1)).

The papers in the volume are presented in groups on high-voltage electron microscopy, scanning electron microscopy, mirror electron microscopy, high resolution, field emission, image formation, lens aberration, superconducting lenses, instrumentation, image recording, specimen stages, physical techniques, diffraction contrast, electron diffraction energy analysis, Lorenz microscopy, radiation damage, crystal growth, dislocations, phase transformation, precipitation, surfaces, polymers, colloids, and quantitative electron microscopy. (J.R.D.)

Corrosion and Erosion

32767 (AERE-M-2403) CALCULATION OF GRAPHITE CORROSION RATE. Users Guide to a Modified Form of the RICHTER II Program in Slab and Spherical Geometries. Kyte, W. S. (Atomic Energy Research Establishment, Harwell (England)). Jan 1971. 15p. Dep. NTIS (U. S. Sales Only).

A description is given of the preparation of input data for the computer program RICHTER IISCS. This program uses a numerical integration method to calculate concentration and burn-off profiles in a section of graphite being corroded by water. The section may have slab, cylindrical or spherical geometry. (auth)

32768 EXPERIMENTAL TECHNIQUES FOR ELECTRON MICROSCOPY STUDIES OF GAS REACTIONS WITH POLYCRYSTALLINE GRAPHITES. Jones, S. S. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Carbon: 8: 673-9(Nov 1970).

In spite of the experimental difficulties involved, structural changes produced in polycrystalline graphites by gas reactions were examined directly at high resolution. Experimental techniques are described which were found satisfactory for an exploratory investigation, using direct transmission electron microscopy, of changes in graphite microstructure produced by reactions with oxygen, carbon dioxide, water vapor and hydrogen. This study was made using disk-shaped graphite specimens which had a thin central area made by mechanical abrasion. The procedures used in the preparation, treatment, and microscopic examination of these specimens are described. Specimen treatment involved both thermal gas reactions, at temperatures between 600 and 6000°C, and electronically-excited reactions initiated by microwave discharge. Specimen examination included weight loss determination, microstructure image study, selected-area electron diffraction analysis, measurement of x-ray emission from impurities, and repeated examination of the same specimen areas before and after treatment. (auth) (UK)

32769 USE OF PARTIAL-PRESSURE MASS SPECTROMETRY IN THE STUDY OF THE THERMAL DESORPTION AND OXIDATION OF CARBON AND GRAPHITE. Austin, F. E.; Brown, J. G.; Dollimore, J.; Freedman, C. M.; Harrison, B. H. (Univ. of Salford, Eng.). Analyst; 96: 110-16(Feb 1971).

A partial-pressure mass-spectrometer system is described for measuring thermally desorbed species from solid surfaces. The system evaluates not only the ratio of masses present in the gaseous phase but also relates the specific mass (mg g^{-1} of solid) desorbed or decomposed during thermal treatment. The extension of the method to include oxidation studies is also described. A study was made of the initial evolution of gases from graphitic and non-graphitic carbons. These range in properties from a ground graphite of specific surface 103 $m^2 g^{-1}$ to a nuclear-type graphite of 0.6 $m^2 g^{-1}$. A study of a nongraphitic carbon, saran charcoal, of molecular-sieve type is also included. The formation of surface oxide on a clean surface at low pressures is evaluated together with the resultant thermal decomposition of the surface oxide. These results together with other published work on graphites are reviewed and used to illustrate the application of the results of thermal desorption to oxidation studies on carbons and graphites. (auth) (UK)

32770 RESISTANCE OF SOME REFRACTORY COMPOUNDS AND HARD ALLOYS TO WEAR INDUCED BY A HIGH-SPEED ABRASIVE-LADEN AIR STREAM. Dan'kin, A. A. Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 841-4(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 73-7(Oct 1970).

Tests are described in which quartz-carrying air streams issuing from nozzles at 7 atm were directed at specimens of Co-WC and TiC-Co-WC cermets, and stainless steel. Wear results are discussed in relation to cermet and stainless steel percentage compositions. (J.R.D.)

32771 RHENIUM AND ITS ALLOYS WITH BORON AS EFFECTIVE NEUTRON ABSORBERS. Arabei, B. G.; Matveev, V. I.; Smirnov, V. P.; Frolova, K. I. At. Energ. (USSR): 29: 295-8 (Oct 1970). (In Russian).

Rhenium and its alloys with boron are of interest for use in reactor control systems, in view of the fact that boron enriched in ^{10}B is the most effective fast neutron absorber followed by europium, rhenium, and tantalum. Materials were prepared combining rhenium and boron in order to study their properties for use in reactors such as corrosion resistance against attack by sodium and compatibility with stainless steel at high temperatures. The alloy compositions investigated included ReB_3 + B (containing 15 wt % boron, with a hexagonal unit cell) and ReB + 7 wt % WB_{12}. The pseudo-alloys were prepared by hot-pressing at 250 kg/cm^2 at 1600 to 1700°C for 5 to 10 minutes. Their effectiveness with respect to reactivity was studied in a critical assembly mock up of the BN-350 reactor while the corrosion resistance against sodium was tested at 700 and 800°C for periods ranging from 500 to 10,000 hours. It was found that the effectiveness of Re and its boron-containing alloys was higher than that of natural enriched boron carbide, and lower than that of highly enriched B_4C. However, the cost per reactivity unit of Re/natural B was lower than that of highly enriched B_4C. The corrosion resistance against liquid sodium was somewhat lower than that of B_4C and much lower than that of CrB_2. Compatibility tests revealed that the steel components are redistributed in the system, under the formation of a superficial Y-phase consisting of (Cr, Mo, Ni)$_4B_3$ or (Cr, Ni, Mo)$_5B_4$. (TTT)

32772 EFFECT OF SUBSTITUTIONAL BORON ON THE KINETICS OF THE CARBON-CARBON DIOXIDE REACTION. Allardice, D. J.; Walker, P. L. Jr. (Pennsylvania State Univ., University Park). Carbon: 8: 773-80(Dec 1970).

Natural graphite flakes were doped substitutionally with boron at atomic levels of 0.2 and 1.0%. The reactivity of compacted samples of these graphites and the undoped material in a dry CO/CO_2 atmosphere (ratio of 0.15) was studied as a function of temperature (925 to 1050°C), carbon burn-off, CO_2 pressure, and pre-treatment in O_2. Boronation lowers the rate of carbon gasification, but does not change the activation energy for the overall reaction. Unlike the reaction in O_2, there is no evidence that retardation is caused by formation of liquid B_2O_3, which would block active sites on the graphite surface. With continuing burn-off above 10%, the graphite surface area and gasification rate remain constant. Boronation increases the order of reaction with respect to CO_2 and decreases the rate constant, k_1, in the Langmuir-Hinshelwood kinetic scheme. (auth) (UK)

Preparation and Fabrication

Refer also to abstracts 32035, 32066, and 32673.

32773 (CEA-N-1419, pp 115-26) TREATMENT OF URANIUM. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). (In French).

In Semiannual report of the Chemistry Department, No. 9, December 1969-May 1970.

Studies on the problems connected with the preparation of different qualities of sinterable UO_2 were continued. In the high-enrichment hexafluoride UF_6 conversion laboratory, a standard batch of direct granulate oxide was prepared by hydrolysis of the hexafluoride in ammonia, and on the basis of preliminary tests can be claimed to sinter well. In the low-enrichment hexafluoride UF_6 conversion laboratory, a line for the manufacture of sinterable oxide by the dry process was set up and the first tests carried out. The possibility of using formic precipitation as a preparation for conversion of uranyl nitrate to an oxide powder is being studied on a laboratory scale. (auth)

32774 (GEAP-13582) SUMMARY OF (U,Pu)O_2 PROPERTIES AND FABRICATION METHODS. Rubin, B. F. (comp.) (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Nov 1970. Contract AT(04-3)-189. 78p. Dep. NTIS.

A compilation is presented of properties and fabrication techniques intended to serve as a reference for those interested in ceramic oxide fuels for fast breeder reactor applications. The PuO_2 content of such fuels are ≥15 wt % and these compounds are thereby distinguished from the mixed oxide fuels with lower PuO_2 concentrations that are recycled in thermal reactors. The bulk of the data and results were developed by investigators of GE, NUMEC, Westinghouse, Argonne National Laboratory, and Battelle Northwest Laboratory. The work of British and French researchers is also included in the references. (auth)

32775 (UJV-2372M) DEGASSING OF URANIUM DIOXIDE PELLETS COMPRESSED WITH BINDERS. Landspersky, H.; Vanecek, I. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). 1970. 22p. (In Czech). NTIS (U. S. Sales Only).

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The effect of heating under argon and hydrogen on weight changes in UO_2 pellets compressed with binders was studied. Polyvinyl alcohol, polyethylene glycol, paraffin, and stearic acid were used as binding agents. The carbon content in pellets heated at various rates and calcined at temperatures of up to 800°C remained high (0.1 to 0.5%). During the subsequent sintering, however, the carbon content fell to 50 to 100 ppM. When a higher degassing temperature (800°C) was employed, the carbon content in the sintered pellets decreased below 50 ppM but the sinterability of UO_2 was impaired and the resulting density was only 93 to 94.5% of the theoretical density. With a degassing temperature of 500°C the resulting density exceeded 95% of the theoretical value and was slightly higher than that attained in the absence of binding agents. The experiments showed that a single continuous furnace can be employed for both degassing and sintering. (INIS)

32776 (WARD-4135-13) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending September 30, 1970. Boltax, A. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jan 1971. Contract AT(30-1)-4135. 142p. Dep. NTIS.

Activities in programs on analytical and experimental studies of mixed oxide fuel pins are summarized. Data and information are included on fuel performance analysis, development of fuel lifetime codes, mixed oxide fuel pin irradiation, grid-type fuel assembly design, development and testing of LMFBR fuel assemblies, development of EBR-II grid-type subassemblies, pellet fabrication, oxide fuel characterization, fuel element fabrication, and product control. (J.R.D.)

32777 MODERN APPLICATIONS OF BeO CERAMICS. I. APPLICATION IN NUCLEAR TECHNOLOGY. Buresch, F. E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Ber. Deut. Keram. Ges.; 48: 53-9(Feb 1971). (In German).

Beryllia is an important material for many applications in microcircuits in electronics. Because of its physical, technological and nuclear properties BeO is also an interesting material for high-temperature reactors. The physical, technological, and nuclear properties of BeO are reviewed. In nuclear reactors, high-energy particles produce lattice defects in BeO which lead to a decrease of the strength of the material, to fracture, and a decrease of its thermal conductivity, while its diffusion increases. Nuclear reactions lead to the formation of lithium and tritium, which absorb thermal neutrons, and of helium which causes a volume increase. These products of nuclear reactions can to a certain extent be eliminated by thermal treatment. However, the radiation damage has so far hindered the economical use of BeO in nuclear reactors. (auth)

32778 NUCLEAR FUEL PELLETS OF UO_2. Nishijima, Toraji (Tokyo Shibaura Electric Co. Ltd., Kawasaki, Japan). Funtai Kogaku; 7: No. 9, 66-72(Sep 1970). (In Japanese).

UO_2 pellets have been used as the nuclear fuel for the proven reactors. Mass production of the pellets is required because of the large amount of consumption; the unrecovered loss of fuel material during production must be less than 1 percent. Safety against chemical toxicity and criticality accidents is required. The fundamental characteristics of UO_2 and the industrial management of the manufacturing process are described. A limitation of UO_2 is low heat conductivity, also UO_2 pellets break in metallic sheaths due to heating, however, UO_2 pellets are expected to be major fuel for the next 20 years. UO_2 produced by the direct method is subjected to refining process to remove F. The relation between salt and produced powder is important for the powder characteristics. The excess oxygen in powder affects sintering, therefore, the sintering mechanism differs due to sintering atmosphere. The development of an advanced technique to decrease the loss of fuel in the process must be investigated. Particularly, the crushing process of agglomerated secondary particles produces the loss owing to flying fine particles. It appears that the loss of more than 1 percent of UO_2 is inevitable in the case of the pellet diameter difference of 0.02mm. The vibration compacting method is promising for the future. (Japan)

32779 SOLID STATE BONDING OF NICKEL, CHROMIUM, AND NICHROME SHEETS TO $\alpha-Al_2O_3$. Calow, C. A.; Bayer, P. D.; Porter, I. T. (Atomic Weapons Research Establishment, Aldermaston, Eng.). J. Mater. Sci.; 6: 150-5(Feb 1971).

Experiments are described to measure the interfacial shear strengths of bonds formed between nickel, chromium and Nichrome sheets hot pressed onto $\alpha-Al_2O_3$ single crystal plaques. Nickel developed bonds of $\sim 8 \times 10^3$ psi in shear when pressing was carried out under non-reducing conditions at 1100°C, 1 tsi for 2 hr in the case of chromium, the effect of pressing temperature (1000 to 1300°C) pressing pressure (½ to 3 tsi) and pressing time (½ to 7 hr) on the bond was investigated. Nickel-chrome alloys produced from alternate nickel and chromium strips showed bond strengths up to 20×10^3 psi while commercial nickel-chrome (containing a silicon impurity) was not as effective in bonding to alumina. In material prepared from alternate strips of nickel and chromium, the degree of alloy homogenization was investigated using microprobe analysis and suggestions made as to the mechanism of the interfacial reactions with alumina. (auth) (UK)

32780 SYNTHESIS, CRYSTAL GROWTH, AND PHYSICAL PROPERTIES OF RARE-EARTH NITRIDE PHASES. Busch, G.; Kaldis, E.; Schaufelberg-Teker, E.; Wachter, P. (Eidgenoessische Technische Hochschule, Zurich). pp 359-73 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The results obtained on the synthesis of the nitrides of the rare earths, scandium and yttrium, by the amalgam method, and on the synthesis of GdN by the hydride method are presented together with results on the crystal growth of the nitrides of Gd, Ho, Dy, Tb, and Eu. Most of these compounds contain between 98 and 96 percent nitrogen. Powders and single crystals were analyzed chemically, magnetically, and optically, and the lattice parameters measured. The results obtained indicate that increased electron concentration improves ferromagnetic coupling in GdN and vice versa. Optical measurements demonstrated complex absorption phenomena in almost all of the compounds, an exception being GdN prepared by synthesis from the hydride. New magneto-optic phenomena were observed below the magnetic ordering temperature. (France)

32781 EUROPIUM AND YTTERBIUM MONOCARBIDES. CRYSTAL STRUCTURE AND METAL VALENCE. Laplace, Alain; Lorenzelli, Robert (CEA, Fontenay-aux-Roses, France). pp 385-95 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The europium carbide EuC_{1-x} was prepared for the first time by sintering. Crystal lattice determination and susceptibility measurements showed that the europium carbide contains Eu^{2+} ions. The europium oxycarbide EuC_xO_y and the ytterbium carbide $YbC_{0.33}$ containing mixtures of Yb^{2+} and Yb^{3+} ions were prepared. (France)

32782 DENSIFICATION OF NICKEL-CARBIDE COMPOSITES. Boiko, P. A.; Shcherban, N. I. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 802-4(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 23-6(Oct 1970).

A study was made of the densification behavior of dispersed Ni-ZrC, Ni-NbC, and Ni-WC charges. It was demonstrated that carbide additions lower the density of nickel compacts and increase their porosity. The effect produced by compaction pressure and carbide content on the density of compacts is identical with that observed in an investigation into the densification behavior of iron-glass composites. (auth)

32783 DENSIFICATION OF CARBON AND GRAPHITE ARTIFACTS BY HOT WORKING AT TEMPERATURES ABOVE 2500°C. Boeder, H.; Fitzer, E. (Univ., Karlsruhe, Ger.). High Temp. - High Pressures; 2: 325-43(1970).

The densification process was studied on a range of starting carbonaceous materials which were subjected, in a mould, to pressures of 250 to 700 kg cm^{-2} (3500 to 10000 psi) at temperatures ranging from 2500 to 2900°C. There is a minimum pressure below which densification cannot be achieved, and this depends on the initial pore size. The final density depends primarily on the pressure, the effect of temperature being small. The time required is of the order of minutes. Selection of the filler affects the process much more than the choice of the binder, the best filler being the so-called soft carbon. The effects of hot working are discussed in terms of changes in bulk density, porosity, and thermal volume expansion. (auth) (UK)

32784 PREPARATION OF CARBIDES OF THE IV-V GROUPS TRANSITION METALS IN THEIR HOMOGENEITY REGIONS. Naumenko, V. Ya. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 799-801(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 20-2(Oct 1970).

Preparation of TiC, ZrC, HfC, NbC, and TaC in their homogeneous phases by reaction of the metal powders with acetylene black in vacuum is described. Data tabulations on the results

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of chemical and x-ray analyses of the synthesized compounds are included. (J.R.D.)

32785 MACHINING OF OXIDES USING GAS LASERS. Cockayne, B.; Gasson, D. B. (Royal Radar Establishment, Malvern, Eng.). J. Mater. Sci.; 6: No. 2, 126-9(Feb 1971).

The use of CO_2-N_2-He gas lasers in the cutting and engraving of oxide materials is demonstrated. The materials investigated were vitreous silica, zirconia, alumina, magnesium aluminate spinel, magnesia and aluminous porcelain. (auth) (UK)

32786 SOME EXPERIMENTS ON EVAPORATION SYNTHESIS: FORMATION OF TiN AND ZrN. Itoh, Akio (Electrotechnical Lab., Tokyo). Denki Shikensho Iho; 34: 877-83(1970).

A new method for the production of certain materials, evaporation synthesis, was developed. Single metal atoms existing in the process of vacuum deposition are sufficiently active to react the activated gas molecules or atoms adsorbed on the surface of a substrate and to form stable compounds such as oxides, nitrides, and carbides. In the case of evaporation synthesis, the surface reaction is accelerated by ejecting the molecular flux of reactant gas simultaneously with the metal-vapor atoms. The formation of titanium nitride and zirconium nitride was studied. The degree of nitridation depends on both the substrate temperature and the ratio of incident frequency of nitrogen molecules to that of metal atoms. Maximum compositions of $TiN_{1.0}$ and $ZrN_{1.9}$ are obtained at optimum substrate temperatures of 320 and 330°C, respectively. The effect of heating the nitrogen on the final composition of the product is appreciable in the case of zirconium–nitrogen system. The specific resistivity and the temperature coefficient of resistivity of the films produced are studied as functions of the film composition. (auth)

32787 HOT-PRESSING OF ZIRCONIUM NITRIDE IN VACUUM. Hirabayashi, Masayuki; Nakatani, Hiroshi. Denki Shikensho Iho; 34: 861-76(1970). (In Japanese).

Zirconium nitride powder was hot-pressed over the temperature range from 1300 to 2500°C in graphite dies in vacuum under different conditions. The following variables were examined in the densification process of zirconium nitride: pretreatments of powder (e.g., thermal treatment in vacuum and in the flow of N_2 gas that might change the composition, and mechanical grinding); sintering aid (i.e., small amounts of additives of metal); sintering temperature; and method of applying pressure. It was confirmed that, in particular, metal additives (1 wt %) which formed a liquid phase at the sintering temperature had effect on the densification process, increasing the density and promoting the grain growth of zirconium nitride. The reaction between nickel and zirconium nitride was also investigated by using x-ray diffraction, and with a microscope and an electron microprobe. It was found that the intermetallic compound $ZrNi_5$ was formed by the interaction of nickel and zirconium nitride in the temperature range from 1400 to 2200°C. An expression for the rate of densification was proposed based on both Murray's equation with no simplification in the plastic flow model of Mackenzie et al. and McClelland's equation including a correction for the variation of an asymptotic end-point density. The proposed equation showed the relation of $\log(\log(1-\rho)) \propto t$ against the relation of $\log(1-\rho) \propto t$ of Murray's simplified equation. It was confirmed that the proposed equation agreed well with experimental data on densification approaching an end-point density. (auth)

32788 TERTIARY COMPOSITE MATERIALS BASED ON TUNGSTEN, BORON, AND CARBIDE, AND METHOD OF PREPARATION. Mandineau, Daniel P. H.; Mourey, Michele Y. C.; Pizzini, Georges P. H.; Poulain, Jacques C. (to Ecole Nationale Superieure des Mines. Societe Nationale d'Etude et de Construction de Moteurs d'Aviation). French Patent 1,598,323. 6 Jul 1970. Filed 5 Dec 1968. (In French).

Composite materials obtained by deposition of boron on tungsten substrates are described along with deposition of boron or silicon carbide on the previously deposited boron layer. A method of preparing these materials is presented. The boron deposit was obtained by decomposition on the tungsten substrate heated to a temperature between 980 and 1150°C, of a mixture of boron halide and hydrogen vapors. The carbide is then deposited by thermal decomposition, on the previously obtained substrate suitably heated, of a mixture of boron or silicon halide, hydrogen and a hydrocarbon. Wires fabricated by deposition of boron layers about 10 microns thick and carbide layers about 35 microns thick on tungsten filaments of 12.7 microns diameter are described. (auth) (France)

32789 GROWTH OF IVa-DIBORIDE SINGLE CRYSTALS IN MOLTEN IRON. Nakano, Kikuo (Government Industrial Research Inst., Nagoya, Japan); Hayashi, Hiroshi; Imura, Toru. Jap. J. Appl. Phys.; 10: 513(Apr 1971).

Single crystals of Group IVA-diborides, namely, TiB_2, ZrB_2, and HfB_2, were grown in molten iron bath. During experiments, cylindrical Mo-heater furnace and 99% purity of Al_2O_3 crucible were used. Each batch (molecular ratio of IVA-diboride and iron was 1 : 9 and total weight was 50 to 70 gr starting materials; 99.5% Ti-powder, 97% Zr-powder, 99% Hf-powder, and 99% B-powder) was heated, in an atmosphere of Ar + 2 to 3% H_2, to the maximum temperature and cooled slowly. The growth conditions were as follows: TiB_2, ZrB_2; 1700°C (max temperature), 1700 to 1400°C (slow cooling interval), 5°C/hr (cooling rate). HfB_2; 1730°C (max temperature), 1730 to 1400°C (slow cooling interval), 5°C/hr (cooling rate). (auth)

32790 FABRICATION OF TRANSPARENT BeO BY HIGH-PRESSURE HOT-PRESSING. Kodaira, K.; Koizumi, M. (Osaka Univ.). Mater. Res. Bull.; 6: 261-5(Apr 1971).

The fabrication of optically transparent BeO with theoretical density of 3.01 g/cm^3 was achieved by high-pressure hot-pressing in the range of 1000 to 1400°C and at 20 kb. The material produced at the optimum condition transmitted light over 60% in the visible range. The rate of densification was observed to be rapid at the above conditions and fully dense BeO was obtained within a few minutes. (auth)

Properties Evaluations

Refer also to abstracts 31917, 31942, 31943, 32698, 32699, 33458, 33460, and 34354.

32791 (AERE-R-5466) SOME OBSERVATIONS ON THE COMPATIBILITY OF URANIUM AND PLUTONIUM NITRIDES WITH SEVERAL STAINLESS STEEL ALLOYS. Allbutt, M.; Junkison, A. R. (Atomic Energy Research Establishment, Harwell (England)). Jun 1967. 36p. Dep. NTIS (U. S. Sales Only).

Previous observations of the compatibility of UN with metals are reviewed. It is shown on thermodynamic grounds that, due to the influence of oxygen impurities, UN will behave in practice as a UN-U_2N_3 mixture while the nitriding potential of PuN will be greater than that of the pure compound. At 900°C stainless steel in contact with UN for 250 hours and above develops a reaction zone of up to 10 microns thickness. Features identified within the reaction zone include metal ex-foliation, precipitation of UO_2, and grain boundary hardening. With the exception of UO_2 precipitation these features are produced by nitrogen alone under the pressure of the UN-U_2N_3 equilibrium. From tests using PuN it is inferred that the behavior of UN/PuN solid solutions will resemble that of a UN/U_2N_3 mixture. (auth)

32792 (IS-T-438) EFFECT OF OXYGEN ON THE STABILITY OF URANIUM–CARBON COMPOUNDS. Witt, Gary George (Ames Lab., Iowa). Feb 1971. Contract W-7405-eng-82. 89p. Dep. NTIS.

Thesis.

The advent of the high-temperature nuclear reactor has stimulated research on possible metallic-ceramic fuels; the two most common being uranium dioxide and uranium carbide. In order to compare these fuels one must first know the desirable characteristics of a high-temperature reactor fuel. These are usually listed as high melting point, high thermal stability and thermal conductivity, good radiation stability, good formability and strength, high uranium density, good compatibility with cladding materials, resistant to oxidation and corrosion, and economical. The dioxides and carbides are similar in many respects; however, their differences are what have prompted investigations of uranium oxycarbide type compounds. The dioxides have good resistance to oxidation and corrosion, but have a low thermal conductivity. The carbides have a high thermal conductivity, but have a narrow composition range and poor resistance to oxidation and corrosion. Combining the oxide and carbide to form an oxycarbide gives a compound having a fairly high thermal conductivity, intermediate resistance to oxidation and corrosion, a larger composition range and economical preparation by vacuum reaction of uranium dioxide with carbon. This investigation is concerned with the effect of oxygen on the stability of uranium-carbon compounds. (auth)

32793 (NP-18738 SORPTION OF ANTIMONY BY SILICA GEL FROM NITRIC ACID AND HYDROCHLORIC ACID SOLUTIONS. Eschrich, H.; Herrera-Huertas, M.; Tallberg, K. (European Company for the Chemical Processing of Irradiated Fuels, Mol (Belgium)). Oct 1970. 23p. (ETR-268). Dep. NTIS (U. S. Sales Only).

The sorption of trace amounts of antimony-125 on silica gel from nitric acid and hydrochloric acid of various concentrations was investigated. It was found that antimony can almost quantitatively be sorbed on silica gel columns from nitric acid solutions

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of less than 0.5 M or higher than about 9 M. The sorption of antimony on silica gel columns from strong nitric acid solutions promotes separation of antimony selectively from fission product solutions. Antimony is strongly sorbed on silica gel columns from hydrochloric acid solutions of less than 0.5 M; the degree of sorption decreases rapidly with increasing acidity being negligibly small at hydrochloric acid concentrations higher than 6 M. (auth)

32794 (RT/ING-(70)19) THERMAL DECOMPOSITION OF U_3O_8 POWDERS. Ferari, S.; Giaquinto, L.; Macioce, L.; Majani, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Oct 1970. 20p. (CONF-700556-3). Dep. NTIS (U. S. Sales Only).

From Italian-Polish meeting; Warsaw, Poland (26 May 1970).

The sintering behavior in nitrogen atmosphere of U_3O_8 powder compacts is reported. On the basis of the shrinkage data of these compacts and the thermogravimetric behavior during decomposition of U_3O_8 powders a first approach to the possible phenomenological mechanism of sintering of these powders is proposed. This approach takes into account the influence of an organic substance on the decomposition of the U_3O_8 powder when heated at high temperature in nitrogen atmosphere. (auth)

32795 (RT/ING-(70)23) THERMAL PROPERTIES OF CERAMIC MATERIALS. Ferro, C.; Patimo, C.; Piconi, C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 26 Nov 1970. 27p. (CONF-700556-5). Dep. NTIS (U. S. Sales Only).

From Italian-Polish meeting; Warsaw, Poland (26 May 1970).

The knowledge of material properties, such as thermal conductivity, is very important for the design and fabrication of nuclear fuel elements. The aim of this work is a description of the high temperature developments concerning thermophysical properties study. A theoretical analysis was performed in order to calculate the systematic errors which can be used for experimental data elaboration. The results of some measurements carried out on ceramic fuel samples as well as the equipment and methods used are described. (auth)

32796 SWELLING AND GAS RELEASE MODELS FOR OXIDE FUELS. Nichols, F. A.; Warner, H. R.; Ocken, H.; Leiden, S. H. (Westinghouse Electric Corp., West Mifflin, Pa.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 12-13(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32797 ANVANCED GAS RELEASE AND SWELLING SUBROUTINE. Poeppel, R. B. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 13(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32798 SWELLING OF OXIDE FUELS AT HIGH TEMPERATURES. Chubb, W.; Hilbert, R. F.; Storhok, V. W.; Keller, D. L. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 13-14(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32799 FUEL-CLAD REACTIONS IN IRRADIATED MIXED-OXIDE FUELS. Johnson, C. E.; Crouthamel, C. E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 17(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32800 FUEL-CLAD REACTIONS OBSERVED IN STAINLESS-STEEL-CLAD MIXED-OXIDE FUEL PIN IRRADIATION. Perry, K. J.; Melde, G. F.; Duncan, R. N. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 17-18(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32801 OBSERVATIONS OF FUEL CLADDING/CHEMICAL INTERACTIONS AS APPLIED TO GCBR FUEL RODS. Fitts, R. B.; Long, E. L. Jr.; Leitnaker, J. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 18-19(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32802 REACTION OF SODIUM WITH MIXED-OXIDE FUELS. Aitken, E. A. (General Electric Co., Pleasanton, Calif.); Evans, S. K.; Melde, G. F.; Rubin, B. F. Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 19-20(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32803 SODIUM-FUEL INTERACTIONS. Blackburn, P. E.; Martin, A. E.; Battles, J. E.; O'Hare, P. A. G.; Hubbard, W. N. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 20-1(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32804 SPATIAL DISTRIBUTION OF INTERGRANULAR POROSITY IN AN EBR-II-IRRADIATED MIXED-OXIDE FUEL ELEMENT. Bullington, D. C.; Leggett, R. D. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 25-6 (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32805 DISTRIBUTION OF GASEOUS FISSION PRODUCTS IN IRRADIATED MIXED-OXIDE FUELS. Johnson, Carl E.; Steidl, David V.; Crouthamel, Carl E. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 27(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32806 FISSION GAS RELEASE FROM FAILED FUEL RODS IN LIQUID-METAL FAST BREEDER REACTORS. Carelli, M. D.; Coffield, R. D. Jr. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 28(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32807 PERFORMANCE CAPABILITY OF ADVANCED FAST BREEDER REACTOR FUELS. Washburn, T. N.; Scott, J. L. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 35(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32808 UNRESTRAINED SWELLING AND FISSION-GAS-RELEASE EXPERIMENTS OF FAST REACTOR FUELS. Grando, C.; Montgomery, M.; Strasser, A. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 36-7(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32809 EUROPIUM(II) AND EUROPIUM(III) COMBINATIONS AND THEIR USE IN ANALYSIS. Stroganova, N. S.; Rousaikina, L. V. (Inst. of Geochemistry and Analytical Chemistry, Moscow). pp 297-307 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

$EuSO_4$ and $EuCO_3$ were synthesized. The valence of Eu, its thermal behavior, structural characteristics, and solubility were investigated in these compounds. The solid phase composition and the solubility in $MeCl_3-K_2CO_3-H_2O$ (Me = Nd, Eu, Yb) systems were investigated as a function of K_2CO_3 excess. The constants of complex ion stability for Nd were calculated by the Ledene method. (auth) (France)

32810 THERMODYNAMIC DATA FOR SOME RARE EARTH CARBIDES BY SOLID-STATE E. M. F. TECHNIQUES. Anderson, J. S.; Bagshaw, A. N. (Oxford Univ.). pp 397-403 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

Body-centered cubic M_2C_3 and body-centered tetragonal MC_2 compounds were observed in the rare-earth/carbon systems of lanthanum, cerium, praseodymium, and neodymium. Thermodynamic data were obtained with solid electrochemical cells in the 700 to 1000°C range. (France)

32811 CHEMISTRY AND PHYSICS OF COMPOUNDS OF METAL-TANTALUM OXIDES. Bergmann, Hartmut (Max-Planck-Gesellschaft zur Foerderung, Frankfurt am Main). Chem. Ztg.; 95: 177-9(1971). (In German).

The recently appeared Gmelin volume Tantal B 2 dealing with Ta compounds represents the basis of this survey which comprises several chemical and physical investigations of compounds between tantalum oxides and metal oxides. (auth)

32812 COALESCENCE OF Al_2O_3 PARTICLES IN MOLYBDENUM AT HIGH TEMPERATURES. Ivanov, V. E.; Nechiporenko, E. P.; Krivoruchko, V. M.; (and others) (Physical-Technical Inst., Kharkov). Inorg. Mater. (USSR) (Engl. Transl.); 6: 1255-60(Aug 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 1427-31(Aug 1970).

The effects of annealing at 1400 to 1800°C on growth rates of Al_2O_3 particles in $Mo-Al_2O_3$ cermets were investigated. It was found that in the diffusion phase of the hardening-particle co-

alescence process, the oxide content variations in the solid solution have the greatest effect. (J.R.D.)

32813 SOLID SOLUTIONS OF SCANDIUM, TITANIUM, VANADIUM, AND CHROMIUM SESQUIOXIDES. Shveikin, G. P.; Alyamovskii, S. I.; Perelyaev, V. A. (Inst. of Chemistry, Sverdlovsk, USSR). Inorg. Mater. (USSR) (Engl. Transl.); 6: 1214-15 (Jul 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 1377-8(Jul 1970).

Results of investigations of transition metal sesquioxide solid solutions are presented. Properties of solid solutions of $Sc_2O3-Ti_2O_3$, $Sc_2O_3-V_2O_3$, and $Sc_2O_3-Cr_2O_3$ are tabulated and discussed. (J.R.D.)

32814 SOME STRUCTURAL AND MECHANICAL CHARACTERISTICS OF AQUEOUS TiC- AND ZrC-BASE SUSPENSIONS. Avgustinik, A. I.; Drozdetskaya, G. V.; Ordan'yan, S. S. (Leningrad Technological Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 10, 854-7(Oct 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 10, 90-4(Oct 1970).

The viscosity of titanium and zirconium carbide slips was investigated, at various solid-to-liquid phase ratios, as a function of the specific surface area of powders and the pH of the medium. It was found that the viscosity of a slip depends on its solid phase content; the best properties are exhibited at a solid phase concentration of 70% for titanium carbide slips and 75% for zirconium carbide slips. The addition of an acid or an alkali to a slip with the aim of decreasing its viscosity is not recommended, because it reduces the viscosity of the dispersing medium Na-carboxymethyl cellulose (CMC), as a result of which the suspension becomes unstable. Titanium and zirconium carbide slips based on a Na-CMC solution are "liquid-like" systems. Titanium and zirconium carbide slips are thixotropic, but the thixotropic structure can easily be destroyed by mechanical mixing in a ball mill, as a result of which the slips become suitable for production purposes. (auth)

32815 EXTENSION OF THE LEAST SQUARES PROCEDURE BY ITERATIVE TECHNIQUES. Oldfield, W.; Markworth, A. J. (Battelle Memorial Inst., Columbus, Ohio). Scr. Met.; 5: 235-9 (Mar 1971).

Iterative procedures useful in determining the relations of best fit in statistical analyses subject to three unknown constants instead of the usual slope and intercept values are described. An illustration of the technique is provided by study of variations in activation energy for creep in UO_2 as related to stoichiometry. (J.R.D.)

32816 OBSERVATION CONCERNING THE PORE STRUCTURE OF EXTRUDED GRAPHITE. Jones, B. F.; Wright, M. G. (Atomic Energy of Canada Ltd., Pinawa, Manitoba). Carbon: 8: 689(Nov 1970).

The strongly oriented pattern observed on extruded graphite is considered to be the result of circumferential surface cracking initiated by rapid diametral expansion, on removal of the circumferential load when a green rod emerges from the dye. Such cracks affect the escape of gas during subsequent carbonisation and thus influence the final pore structure. (UK)

32817 INCOMPLETE PORE DIFFUSION EFFECT ON INTERNAL BURNING OF CARBON. Tien, R. H.; Turkdogan, E. T. (United States Steel Corp., Monroeville, Pa.). Carbon: 8: 607-21(Nov 1970).

The internal burning of carbon, e.g. graphite or coke, controlled simultaneously by the counterdiffusion of CO_2 and CO in the pores and the chemical reaction on the pore walls, is investigated through mathematical analysis. Because of the strong poisoning effect of CO on the rate of oxidation of carbon, incomplete pore diffusion markedly reduces the depth of internal burning. The effects of particle size, temperature and pressure on the rate of oxidation of graphite and coke in CO_2-CO mixtures derived from the mathematical analysis are found to be in reasonable accord with present and previous experimental observations. At the limiting case of incomplete internal burning, i.e. pore diffusion control, the rate per particle is found (1) to be proportional to the external geometrical surface area, (2) to be independent of pressure, and (3) to have an apparent heat of activation half of that for complete internal burning (chemical reaction control). (auth) (UK)

32818 HYDRIDES AS NEUTRON MODERATOR AND REFLECTOR MATERIALS. Vetrano, J. B. (Battelle-Northwest, Richland, Wash.). Nucl. Eng. Des.; 14: 390-412(Feb 1971).

Properties of hydrides of metals in periodic Groups IA, IIA, IIIB, IVB, and VB for use as neutron reflectors and moderators are reviewed. Information is included on preparation, machining, physical properties, mechanical properties, special properties, and radiation effects. (J.R.D.)

32819 NUCLEAR FUEL CONTAINING PLUTONIUM BOROCARBIDES. Sullenger, Don B. (to United States Atomic Energy Commission). U. S. Patent 3,575,874. 20 Apr 1971. Filed 29 Apr 1969.

A ceramic fuel for breeder reactors or the like is described. The fuel has a high radiation and thermal stability and is composed of a group of plutonium borocarbides and plutonium boronitrides, uranium being substitutable for or includable with the plutonium, and the boron constituent being essentially boron-11. (Official Gazette)

32820 STANDARD METHOD OF TEST FOR MOISTURE IN GRAPHITE. ASTM C 562-69. Philadelphia; American Society for Testing and Materials (1969). 2p. Available from American Society for Testing and Materials, Philadelphia.

This method covers the determination of the percentage of moisture in graphite. This method is feasible only for the volatile moisture present on the graphite due to absorption from the atmosphere and is not intended to give representative moisture data for graphite which was exposed to liquid water such as rain, puddles, etc. It is not likely that nuclear graphite would be subjected to any high liquid water concentrations so that this type of water is not germane to analyses of graphite. (auth)

32821 CERAMIC AND CERMET MATERIALS FOR HIGH-DUTY EXTRUSION DIES. Leibold, Hans; Roenigk, Bruno (Wieland-Werke AG, Ulm, Ger.). Z. Metallk.; 62: 270-3(Apr 1971). (In German).

Extrusion dies made of stabilized zirconium oxide show very good life times in the extrusion of nickel silver alloy bars. Practical applicability is limited to simple die shapes, since machining is difficult. Due to the fact that zirconium oxide has a tendency to adhere to layers of scale the number of copper alloys that can be extruded with these dies is quite limited. Dies made of aluminum oxide can also be used for extruding. At present their life times are lower than those of dies of stabilized zirconium oxide. Aluminum oxide, however, is quite inexpensive. Cermets of molybdenum-zirconia are easily machined and scale does not adhere to them. At medium temperatures and extruding pressures superior life times at narrow tolerances are achieved if the profile shapes are not too complicated. (auth)

32822 THERMAL DIFFUSIVITY OF PYROLYTIC ZIRCONIUM CARBIDE. Fridlender, B. A.; Neshpor, V. S. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 750-3(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 795-8(Jul-Aug 1970).

The results of an investigation into the thermal diffusivity of pyrolytic zirconium carbide samples obtained by chemical gas-phase deposition from a vapor-gas mixture of zirconium tetrachloride, methane, and hydrogen on a pyrolytic graphite substrate at 1500°C are presented. (auth)

Structure and Phase Studies

Refer also to abstract 32747.

32823 (HEDL-TME-71-45) MICROSTRUCTURE CHARACTERISTICS OF PNL-6 IRRADIATION TEST FUEL. Carlson, M. C. J. (Hanford Engineering Development Lab., Richland, Wash.). Mar 1971. Contract AT(45-1)-2170. 27p. Dep. NTIS.

An extensive program of fuel characterization has been developed to provide quantitative porosity characterization, grain structure characterization, and composition distribution measurements for as-fabricated mixed-oxide test fuels to a level consistent with anticipated postirradiation examination of the fuel. Quantitative microstructure characteristics are shown for representative fuel fabrication batches in EBR-II irradiation subassembly PNL-6. The evaluation results show that excellent reproducibility of porosity characteristics within and among fuel batches can be achieved by close process control. Results of evaluation of composition distributions show that the mechanical mixing process used in preparation of PNL-6 fuel has produced a high degree of compositional uniformity. (auth)

32824 (LA-tr-71-19) BORON CARBIDE CONTAINING ALUMINUM. Lipp, A.; Roeder, M. Translated for Los Alamos Scientific Lab., N. Mex., from Z. Anorg. Allg. Chem.; 343: 1-5(1966). 7p. Dep. NTIS.

Aluminum-containing boron carbides were obtained by reacting boron carbide with aluminum at temperatures exceeding 1000°C under pressure or in a hydrogen atmosphere. In the ideal case, the products obtained have an empirical formula of $B_{12}C_2Al$. Their lattice is enlarged compared to that of B_4C and is elongated par-

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ticularly in the direction of the hexagonal c-axis. The lattice constants are: $a_0 = 5.65$, $c_0 = 12.39$ Å and $c/a = 2.193$. Their microhardness of 2,500 kg/mm² under a load of 100 g is close to that of silicon carbide. Besides Al, it is conceivable that other elements might be incorporated, thus opening up a new class of compounds having the general formula $B_{12}C_{3-n}Me_n$. (auth)

32825 SURFACE COMPLEXES ON CARBON. I. A PRELIMINARY INVESTIGATION OF SURFACE OXYGEN COMPLEX ON A NON-GRAPHITIC CARBON. Dollimore, J. (Univ. of Salford, Eng.): Freedman, C. M.; Harrison, B. H.; Quinn, D. F. Carbon: 8: 587-96(Nov 1970).

A preliminary investigation was made into the behavior of the surface oxygen complex during its formation and thermal desorption from the cleaned surface of a non-graphitic carbon. Using a direct sampling mass spectrometric technique a reasonable agreement was obtained between the amount of oxygen chemisorbed as surface oxide and that obtained from analysis of the thermal desorption products CO and CO_2. The extent of the surface oxygen complex coverage was shown to be of the order of 3% of the total surface. The thermal desorption products CO and CO_2 were found to obey separately the Elovich equation for desorption in the temperature range 400°–900°C. As a consequence of the mechanism by which thermal desorption occurred, a linear plot of increasing activation energy of desorption of CO vs. decreasing coverage θ of the active sites was obtained. A comparison is made between the observed behavior of surface oxide on a non-graphitic carbon and that obtained on graphitic carbons. (auth) (UK)

32826 PHASE EQUILIBRIA IN THE Mo–TiC–Ti REGION OF THE TERNARY SYSTEM Mo–Ti–C. PART II. Eremenko, V. N.; Velikanova, T. Ya. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 744-7(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 57-61(Sep 1970).

A study was made of the phase equilibria in the Mo–TiC–Ti region of the ternary system Mo–Ti–C in 1400°C. The isothermal section of the system Mo–TiC–Ti at 1400°C was constructed. The polythermic sections of the system Mo–TiC–Ti at 20 and 30 at. % C were established. It is shown that the direction of the tie lines in the $\delta + \beta$ region is parallel to the quasi-binary Mo–TiC section at Ti contents ranging from 20 to 48 at. % in the 20 at. % C section and is independent of temperature. The distribution coefficient K for the two-phase $\delta + \beta$ region on the solidus surface was calculated. The coefficient was found to be 34 ± 8 at titanium contents ranging from 20 to 58 at. % in the 20 at. % C section. It was found that the boundary of the homogeneity region of the δ-phase in the Mo–TiC section lies at the 46 at. % Ti–46 at. % C composition at 1700°C and 46.5 at. % Ti–46.5 at. % C composition at 1400°C. (auth)

32827 RARE EARTH ELEMENTS IN TERNARY SOLID SOLUTIONS BASED ON ZIRCONIA. Glushkova, V. B.; Koehler, E. K.; Kuznetsov, A. K.; Tichonov, P. A. (Leningrad State Univ.). pp 209-20 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The conditions for the synthesis of the solid solutions ZrO_2–Y_2O_3–CaO, ZrO_2–Y_2O_3–MgO, ZrO_2–Y_2O_3–Nd_2O_3, and ZrO_2–Nd_2O_3–CaO in the temperature range 1250 to 1900°C were determined by x-ray diffraction and by chemical analysis of the phases. Between 1250 and 1400°C, the precipitation of the ternary solid solution lags behind the bonding processes of oxides in the solid solution lattice. The stability of ternary solid solutions synthetized in the 1200 to 1400°C range was studied. The addition of Y_2O_3 increases the stability of the solid solutions ZrO_2–MgO, ZrO_2–CaO, and ZrO_2–Nd_2O_3 and the addition of Nd_2O_3 increases the stability of the solid ZrO_2–CaO solutions. By studying the ternary and binary solid solutions: ZrO_2–MO–Ln_2O_3 and ZrO_2–Ln_2O_3 (M = Ca or Mg, Ln = Y, Nd, Sm) the effect of the synthesis temperature on stability and rate of decomposition was examined. A mechanism for the decomposition of binary and ternary solid solutions is proposed. Measurements on the ternary solid solutions ZrO_2–Y_2O_3–MgO, ZrO_2–Y_2O_3–CaO, and ZrO_2–Y_2O_3–Nd_2O_3 up to 1650°C revealed their high electrical conductivities. (auth) (France)

32828 SOLIDIFICATION AND PHASE DIAGRAMS AT HIGH TEMPERATURES FOR LANTHANIDE SESQUIOXIDE–ZIRCONIA SYSTEMS. Rouanet, Alain (CNRS, Montlouis, France). pp 221-35 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The investigations were made by thermal analysis at very high temperatures in air, and x-ray diffraction at high temperatures and allowed the complete solidification and phase diagrams to be determined near the melting point in lanthanide sesquioxide zirconia systems. The results obtained indicate for zirconia-enriched compositions the stabilization conditions for the high-temperature zirconia cubic phase, for the sesquioxide-rich compositions, the effect of zirconia additions on the thermal stability of the several allotropic varieties of lanthanide sesquioxides, and the transition made between these two composition domains, together with the changes in refractory character with composition. For all the ZrO_2–Ln_2O_3 systems except ZrO_2–Lu_2O_3 (as yet not investigated), the solidification diagram is characterized by the existence of a eutectic for the two phases, one being cubic centered C_2, and the other being cubic or hexagonal. (auth) (France)

32829 EXISTENCE OF SUBSTOICHIOMETRIC RARE EARTH NITRIDES. STUDY OF GADOLINIUM OXYNITRIDES. Lorenzelli, Nicole; Melamed, Jeanne; Marcon, Jean-Pierre (CEA, Fontenay-aux-Roses, France. pp 375-83 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

The existence of nonstoichiometry in rare earth nitrides was investigated, especially for lanthanum, cerium, gadolinium, and holmium. No large substoichiometry ($x \simeq 0.05$ for MN_{1-x}) was found, either by arc melting or by metal reduction at high temperatures. The oxygen solubility in the gadolinium nitride was determined and the ternary diagram Gd–N–O proposed. (France)

32830 STUDY OF YTTRIUM CARBOHYDRIDES AND YTTRIUM SULFOHYDRIDES BY X-RAY AND NEUTRON DIFFRACTION. Lobier, G. (CEA, Montrouge, France). pp 405-17 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

X-ray and neutron diffraction studies of the hexagonal ternary compounds, Y_2CH_2 and Y_2CH_3, show that in both structures, the carbon atoms are ordered and located periodically in alternate octahedral planes. Hydrogen atoms first occupy the tetrahedral sites close to the plane of the octahedral vacancies; but, before these octahedral positions are fully occupied, some hydrogen atoms go into the interstitial octahedral positions (case of Y_2CH_2). For higher hydrogen concentrations (Y_2CH_3), the tetrahedral sites are occupied and the additional hydrogen atoms randomly distribute over the free octahedral sites. (auth) (France)

32831 PHASE DIAGRAM OF THE SYSTEM Dy_2O_3–SrO. Lopato, L. M.; Kushchevs'kii, A. E.; Shevchenko, O. V. (Inst. of Problems in Material Studies, Kiev). Dopov. Akad. Nauk Ukr. RSR, Ser. B; No. 3, 246-8(Mar 1971). (In Ukrainian).

Within the temperature range of 1300 to 1400°C a diagram was plotted of the binary system Dy_2O_3–SrO. In the system compounds $SrDy_2O_4$ and $SrDy_4O_7$, there exist domains of solid solutions on the base of initial oxides and a drop in temperatures of polymorphous transformations C ⇌ B, B ⇌ A, A ⇌ H and H ⇌ X is observed for dysprosium oxide with addition of strontium oxide. (auth)

32832 OPERATING CHARACTERISTICS OF AN ION-BOMBARDMENT APPARATUS FOR THINNING NON-METALS FOR TRANSMISSION ELECTRON MICROSCOPY. Gillespie, P.; McLaren, A. C.; Boland, J. N. (Monash Univ., Clayton, Australia). J. Mater. Sci.; 6: 87-9(Jan 1971).

An apparatus for ion bombardment for the preparation of thin foils of non metals for transmission electron microscopy was developed similar to that described by Barber (J. Mater, Sci. 5: 1(1970)) except that the specimen was bombarded from each side by a single ion beam at normal incidence. Details of the discharge characteristics of the ion-gun and the energetics of the ion-beam impinging on the specimen surface are given. The technique was used principally in the study of dislocations and other defects in naturally and experimentally deformed minerals and rocks. (UK)

32833 TECHNIQUE FOR STUDYING SOLID-PHASE CONTACT INTERACTION WITH THE AID OF ELECTRON-BEAM HEATING. Yurchenko, O. S.; Shlyuko, V. Ya. (Kiev Engineering Inst.). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 770-1(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 91-3(Sep 1970).

The compatibility of refractory compounds was tested by placing couples to be evaluated in contact and heating by electron beams. Solid phase interactions of Zr–WSi_2, Ti–$MoSi_2$, Ti–WSi_2, and Zr–$MoSi_2$ couples were examined microscopically. New phases were found in each pair. (J.R.D.)

32834 NATURE OF THE HOMOGENEITY REGIONS CHARACTERISTIC OF COMPOUNDS OF THE TRANSITION METALS WITH CARBON AND NITROGEN. Samsonov, G. V.; Kuchma, A. Ya.; Timofeeva, I. I. (Inst. of Materials Science, Kiev). Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 754-8(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 69-74(Sep 1970).

Results of research show that the width of homogeneity regions in the case of compounds of the transition metals with carbon and nitrogen is determined by the presence in the lattice of unlocalized electrons and by the latter's ability to stabilize the electronic configuration responsible for the existence of any given structure. The width of homogeneity regions decreases with a rise in the degree of localization of the valency electrons in energetically stable configurations and a corresponding decrease in the concentration of the unlocalized part of the valency electrons. (J.R.D.)

32835 STRUCTURAL ANALYSIS OF THE URANIUM–OXYGEN SYSTEM. Kim, Key Soo (Atomic Energy Research Inst., Seoul). New Phys. (S. Korea); 10: 165-73(Dec 1970).

There are many uranium–oxide phases, UO_2, U_4O_9, U_3O_7, U_5O_{13} (or U_2O_5, U_8O_{21}), U_3O_8, and UO_3, with a wide range of nonstoichiometry designated UO_{2+x}, U_4O_{9-y}, U_3O_{7+w}, U_5O_{13+v}, and U_3O_{8-z}. Much experimental data concerning phase equilibria, crystal structures, phase transitions, and physical properties that have reported lately are summarized and assessed from the view point of structure with emphasis on nonstoichiometry. Particular emphasis is placed on the boundaries in the phase diagram, variations of crystal structure which depend on temperature, and O/U composition. Overall structural analysis of the uranium–oxygen system is discussed on the basis of available data. (auth)

32836 PHASE DIAGRAM OF THE SYSTEM ZrB_2–Re. Avgustinik, A. I.; Ordan'yan, S. S.; Serbezova, R. Ya.; Fonareva, I. F. (Leningrad Technological Inst.). Inorg. Mater. (USSR) (Engl. Transl.); 6: 1244-6(Aug 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 1414-16(Aug 1970).

The reaction of ZrB_2 and rhenium was studied. The solubility of rhenium in ZrB_2 at the eutectic temperature is very small (less than 0.1 wt %), and vice versa. The phase found for ZrB_2–Re is quasibinary and of the eutectic type. The composition of the eutectic is 45 at. % Re, the eutectic temperature is 2100 ± 40°C. (auth)

32837 REACTIONS OF NICKEL WITH SAMARIUM HEXABORIDE AND BORON. Romashov, V. M.; Timofeeva, N. I.; Frolova, K. I.; Romanovich, I. V. Sov. Powder Met. Metal Ceram. (Engl. Transl.); No. 9, 762-6(Sep 1970).

Translated from Porosh. Met., Akad. Nauk Ukr. SSR; No. 9, 80-6(Sep 1970).

The reactions between Ni and SmB_6 were investigated. The products were examined by x-ray diffraction and metallographic methods. The various phases were subjected to microhardness tests and microprobe analyses. The results are discussed and presented as an equilibrium diagram for the B-rich region of the Ni–Sm–B system. (J.R.D.)

32838 REACTIONS OF EUROPIUM HEXABORIDE AND REFRACTORY METALS. Bakarinova, V. I.; Savitskii, E. M.; Arabei, B. G.; Salibekov, S. E. Inorg. Mater. (USSR) (Engl. Transl.); 6: 1818-19(Nov 1970).

Translated from Izv. Akad. Nauk SSSR, Neorg. Mater.; 6: 2071-2(Nov 1970).

The reactions of Hf, Ta, and W with EuB_6 were investigated. Results are discussed for a series of compounds formed with each pair of elements as a function of temperature. (J.R.D.)

32839 CONSTITUTION AND SOME PROPERTIES OF COPPER–BORON ALLOYS. Rexer, J.; Petzow, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall; 24: 1083-6(Oct 1970). (In German).

The structure of the Cu–B system was reviewed on the basis of microscopic, x-ray, thermal, and chemical investigations. Cu and B form a simple eutectic system with the eutectic point at 13.3 at. % B and 1013°C. The Cu–B system occupies a special position in the metal-B systems in which neither compound nor miscibility gaps occur in the liquid state. The maximum solubility of Cu in B is 2.8 at. % at 950°C. The placement of the Cu atoms in the B lattice is ordered. (tr-auth)

32840 CATION DIFFUSION IN UO_2-BASED SOLID SOLUTIONS AS A FUNCTION OF STOICHIOMETRY. Lee, H. M.; Alcock, C. B. (Univ. of Toronto). Proc. Brit. Ceramic Soc.; 19: 85-93(Mar 1971).

The self-diffusion coefficients of thorium and uranium in UO_{2+x}, $Th_{0.25}U_{0.75}O_{2+x}$, $Th_{0.5}U_{5.0}O_{2+x}$ and $U_{0.95}Y_{0.05}O_{2+x}$ at 1400°C were measured as a function of stoichiometry using alpha-ray spectrometry with the isotopes of ^{230}Th and ^{233}U. The diffusion coefficients varied as a function of stoichiometry, the variation being expressed by the equation $\log D = (2/5)\log(x/1-x) + C$ (T). This suggests that a vacancy mechanism is operative and the defect complexes $(U^{5+}-O_i-U^{5+})$ are predominant in $Th_{0.25}U_{0.75}O_{2+x}$, $Th_{0.5}U_{0.5}O_{2+x}$ and for the small values of x in UO_{2+x}. In $U_{0.95}Y_{0.05}O_{2+x}$ the cation diffusion coefficients are very close to those found for UO_{2+x}. When x in UO_{2+x} takes values beyond about x = 0.1, the results could not be explained by a simple vacancy mechanism. It is suggested that the incorporation of microdomains of U_4O_9 may cause the formation of dislocations, the difference between the sizes of the unit cells, thereby providing short-circuit paths for enhanced cation diffusion. (auth) (UK)

Radiation Effects

Refer also to abstracts 32643, 32755, 34358, 34361, 34392, and 34439.

32841 (AERE-R-6595) FORMATION OF GAS BUBBLES IN FISSILE MATERIAL DURING REACTOR IRRADIATION. Wham, A. D. (Atomic Energy Research Establishment, Harwell (England)). Nov 1970. 35p. Dep. NTIS (U. S. Sales Only).

The formation of fission gas bubbles in solids was considered in conditions where the resolution of gas from bubbles is appreciable. In such conditions the Greenwood theory is shown to apply only at high temperatures and short irradiation times. At low temperatures precipitation is delayed at short irradiation times. For longer irradiation times at all temperatures, the irradiation enhanced generation rate due to resolution of gas from bubbles outweighs the natural generation rate and the number of nuclei increases linearly with time until numbers are eventually limited by the agglomeration of bubbles by random motion. The number of bubbles predicted by this nucleation–agglomeration theory agrees with experimental observation in the case of uranium dioxide, but may not agree in the case of uranium, for which the resolution parameter may not be high enough. The effect of the theoretical predictions of bubble number and size on swelling and gas migration is discussed for uranium dioxide. (auth)

32842 (GA-10533) RESEARCH ON GRAPHITE. Quarterly Progress Report for the Period Ending February 14, 1971. Engle, G. B.; Price, R. J.; Bokros, J. C. (Gulf General Atomic, Inc., San Diego, Calif.). 12 Mar 1971. Contract AT(04-3)-167. 14p. Dep. NTIS.

The work concerning research on graphite completed during the report period is summarized. Irradiations of nuclear graphites and model carbons were continued to a maximum fluence of 2×10^{22} n/cm² (E > 0.18 MeV) at a maximum temperature of about 1280°C. Physical properties and structural characterizations for the unirradiated graphites are reported. The microstructure of a needle-coke type nuclear graphite was determined in some detail. It was shown to consist of a range of carbon structures with varying crystallite sizes and particle shapes. (auth)

32843 (RD/B/N-1716) OBSERVATIONS DEMONSTRATING THE RE-SOLUTION OF GAS FROM BUBBLES AND SINTERING PORES DURING THE IRRADIATION OF UO_2 AT A HIGH TEMPERATURE. Turnbull, J. A.; Cornell, R. M. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jun 1970. 9p. Dep. NTIS (U. S. Sales Only).

Samples of UO_2 have been irradiated to a total dose of 5×10^{23} thermal neutrons/m² at a constant temperature of 1200°C. Examination by scanning electron microscopy before and after irradiations shows the removal of all but the largest sintering pores. Transmission electron microscopy of preirradiated and annealed material shows a drastic alteration in the intragranular fission gas bubbles by the above irradiation. Both observations confirm the existence of an efficient re-solution process at power reactor operating temperatures. (auth)

32844 (RISO-M-1350) REVIEW OF DANISH IRRADIATION EXPERIMENTS IN THE HALDEN BOILING WATER REACTOR. Knudsen, Per (Danish Atomic Energy Commission, Risoe. Research Establishment). Feb 1971. 32p. Dep. NTIS (U. S. Sales Only).

Ten Danish UO_2-Zr fuel assemblies have been manufactured for in-pile performance testing and evaluation of design parameters in the Halden Reactor in Norway. The eight assemblies irradiated so far have shown a generally good performance with a maximum average assembly burnup of 13,500 MWd/t UO_2 (corresponding to 16,600 MWd/t UO_2 peak pellet). One fuel pin out of a total of 88 has failed, probably as a result of internal attack of fission product iodine. Pellet stacks in one assembly decreased in volume during irradiation; this is explained as a result of fuel-clad mechanical interaction leading to compressive creep of the UO_2. Five helical

plenum springs of Inconel X-750 in the fuel pins of one assembly were fractured, because heat treatment after spring manufacture was inadvertently omitted. (auth)

32845 (RT/ING–(70)20) FUEL MICROSTRUCTURE VARIATION AS A CONSEQUENCE OF THE FIRST IRRADIATION PERIODS AND APPROACH-TO-POWER. Calza Bini, A.; Ferrante, E.; Nobili, A.; Rotoloni, P. L.; Testa, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Oct 1970. 38p. (CONF-700556–2). Dep. NTIS (U. S. Sales Only).

From Italian–Polish meeting; Warsaw, Poland (26 May 1970).

An experimental investigation was undertaken on the microstructure variations of fuel material during the first minutes in the reactor, as functions of time and different modes of approach-to-power. A phenomenological model of fuel behavior during the first start-up which seems to influence the fuel life in the reactor was derived from the obtained results. (auth)

32846 (SC-T-71-3017) EXPLOSION-LIKE PROCESSES DURING THE PULSED TREATMENT OF MATERIALS BY AN ELECTRON BEAM. Noskov, D. A.; Pankovets, N. G. Translated by Marcel I. Weinreich (Sandia Labs., Albuquerque, N. Mex.), from Fiz. Khim. Obrab. Mater.; No. 4, 16-20(1970). 12p. Dep. NTIS.

Results are presented of observations on the processes of the expulsion of matter during an intense pulsed bombardment of solid bodies. The expulsion of substance from the influence of the beam possesses an explosion-like character in a number of instances. In the majority of metals, one observed phenomena of thermal explosions whose action ejected the metal from the contact point of the beam—whereby the ejection of the surface material occurs in the form of tiny droplets. Explosion-like processes during the bombardment of diamonds, glass, and ceramics are described. (auth)

32847 ANALYSIS OF MIXED-OXIDE FUEL ELEMENT IRRADIATIONS USING THE LIFE-I COMPUTER CODE. Jankus, V. Z.; Weeks, R. W. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 8(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32848 COMPARISON OF FMODEL PREDICTIONS WITH EBR-II IRRADIATION DATA. Homan, F. J.; Bridges, W. H.; Lackey, W. J.; Cox, C. M. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 8-10(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32849 COMPARISON OF MEASURED AND PREDICTED DIAMETER INCREASE OF TWO STAINLESS-STEEL-CLAD MIXED-OXIDE FUEL PINS IN A FAST REACTOR. Jackson, R. J.; Leggett, R. D.; Weber, J. W.; Pember, L. A. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 10-11(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32850 IN-REACTOR RESTRUCTURING TEMPERATURES AND KINETICS FOR $(U,Pu)O_2$. Olsen, A. R.; Fitts, R. B.; Lackey, W. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 24-5(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32851 RESPONSE OF AN EBR-II-IRRADIATED, MIXED-OXIDE FUEL PIN TO AN OVERPOWER TRANSIENT IN TREAT. Culley, G. E.; Leggett, R. D.; Bard, F. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 29-30(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32852 OXIDE FUEL BEHAVIOR DURING TRANSIENT OVERPOWER CONDITIONS. Thomas, Garry R.; Field, John H. (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 30-1(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32853 PERFORMANCE OF SPHERE-PAC AND PELLETIZED $(U,Pu)O_2$ DURING SEVERE OVERPOWER TRANSIENTS. Cox, C. M.; Cuneo, D. R.; Manthos, E. J. (Oak Ridge National Lab., Tenn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 31-3(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32854 IRRADIATION TESTING OF FAST BREEDER REACTOR$(U,Pu)O_2$ FUELS. Lindgren, J. R. (Gulf General Atomic, Inc., San Diego, Calif.); Flynn, P. W.; Baldwin, N. L.; Fitts, R. B.; Longest, A. W. Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 33-4(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32855 SWELLING OF UC AND UN AT HIGH TEMPERATURES. Hilbert, R. F.; Storhok, V. W.; Chubb, W.; Keller, D. L. (Battelle Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 35-6(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32856 MIXED-NITRIDE FUEL IRRADIATION PERFORMANCE. Bauer, Arthur A.; Brown, John B.; Fromm, Earle O.; Storhok, Victor W. (Battele Memorial Inst., Columbus, Ohio). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 37-9(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32857 THERMAL AND FAST IRRADIATION OF SODIUM-BONDED (U,Pu)C FUEL AND FUEL ELEMENTS. Clifford, J. C.; Barner, J. O.; Cubitt, R. L.; Kirkpatrick, D. C. (Los Alamos Scientific Lab., N. Mex.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 39-40(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32858 EFFECTS OF IRRADIATION ON URANIUM–PLUTONIUM CARBIDE FUEL RODS TO 65,000 MWd/T BURNUP. Strasser, A.; Montgomery, M.; Powers, R. (United Nuclear Corp., Elmsford, N. Y.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 40-1(1971).

From Conference on fast reactor fuel element technology; New Orlenas, La. (13 Apr 1971). See CONF-710414.

32859 IRRADIATION BEHAVIOR OF SODIUM-BONDED (U,Pu)C FUEL PINS. Harbourne, B. L. (Westinghouse Electric Corp., Madison, Pa.); Levine, P. J.; Biancheria, A.; Latimer, T. W. Neimark, L. A. Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 41-2(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

32860 RADIATION SINTERING OF MAGNESIA: PORE STRUCTURE STUDIES. Mikhail, R. Sh.; Ragai, J. (American Univ., Cairo). Radiat. Eff.; 7: 211-18(Feb 1971).

^{60}Co γ-ray irradiation of a nonequilibrium surface of magnesium oxide produced tremendous effects on both the extent of the surface area and on the pore structure. In all cases investigated, incompletely decomposed crystals showed appreciable lowering of surface area which indicated activated sintering of the material. The pores present are mainly wide, but with a very narrow distribution of their sizes. Their most probable hydraulic radius is about 10 Å. Upon irradiation, sintering is accompanied by widening of pores, and a second group of pores showed its appearance in the pore size distribution curves. These effects seem to be associated with the presence of traces of the volatile component of the parent material, and in particular with the presence of traces of water vapor. Irradiation of the completely decomposed material produced no changes in surface area or pore structure. The role played by water vapor in accelerating the sintering of magnesia is discussed and possible explanations are given for the effects of irradiation. Dual effects of water vapor might lead to the sintering acceleration of magnesia: chemisorption of OH groups which create cation vacancy on the surface leading to activated surface diffusion, and oxygen bridging between two adjacent/or opposite OH groups particularly in narrow pores, leading to their blocking. (auth)

32861 CHANGES OF THE PHYSICAL AND MECHANICAL PROPERTIES OF GRAPHITE IN THE TOKAI NUCLEAR POWER STATION. Sato, Sennosuke; Ito, Hisanori; Honda, Toshio; Yoshida, Hiroshi; Ohmichi, Toshihiko (Japan Atomic Energy Research Inst., Tokai). Proc. Jap. Congr. Mater. Res.; No. 12, 195-200(Mar 1969).

Graphite is the main structural material for the reactor in the Tokai Atomic Power Station of JAPC, a Calder Hall type reactor with gas cooling. For monitoring purpose, a total of 10 channels, running from top to bottom of the reactor, were employed and in each channel 15 containers with graphite specimens were inserted. In the first periodic inspection of channel G, set 165 cm away from the core center, 1005 test pieces of graphite were examined. Some of them were of moderator grade, while others were of reflector grade. The result of measurements agreed fairly well with the data expected in the design of the power station, and the operational safety is sufficiently ensured. The data obtained should contribute to the future construction of similar reactors. The re-

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sults of this first inspection or monitoring of the radiation damage of graphite represented by dimensional change, oxidation weight loss, stored energy, thermal conductivity, and mechanical strength are presented. (Japan)

32862 GROWTH RATE OF HELIUM PORES IN IRRADIATED BERYLLIUM OXIDE DURING ANNEALING. Khudyakov, A. V. At. Energ. (USSR); 30: 54-5(Jan 1971). (In Russian).

BeO samples were given an integral neutron dose of 5×10^{20} neutrons/cm^2 to create a concentration of helium atoms of about 1.2×10^{19} cm^{-3}. The samples were annealed at 1400 and 1500°C. From time to time, bare replicas shadowed with chromium were taken from fresh splittings in order to follow the pore growth under an electron microscope. The total volume of the pores was measured microscopically on polished samples. The results show that at 1400°C three time intervals with different porosity can be isolated. Up to 20 min there is a rapid development of fine pores. Then up to 100 min the pores attain a size greater than 0.2 micrometers. Then all pores become larger; the growth rate slows down, and no new fine pores appear. After a 15-hr anneal the total porosity in the sample increases from 8 to 12%. At 1500°C the first stage of development is not observed, and the second and third stages are accelerated (the total porosity attains 12% in 4 hours). The average size of the pores is described by the equation: $l = l_0 t^x$. Here at 1400°C, $l_0 = 0.016$ micrometers, $x = 0.8 \pm 0.1$, and at 1500°C $l_0 = 0.1$ micrometers, and $x = 0.7 \pm 0.2$. In this case l is the average size of the pores, and t is the time in minutes. (TTT)

32863 FORMATION OF GAS BUBBLES IN FISSILE MATERIAL DURING REACTOR IRRADIATION. Whapham, A. D. (Atomic Energy Research Establishment, Harwell, Eng.). Phil. Mag.; 23: No. 185, 987-1010(May 1971).

The formation of fission gas bubbles in solids was considered in conditions where the re-solution of gas from bubbles is appreciable. In such conditions the Greenwood theory is shown to apply only at high temperatures and short irradiation times. At low temperatures precipitation is delayed at short irradiation times. For longer irradiation times at all temperatures, the irradiation-enhanced generation rate due to re-solution of gas from bubbles outweighs the natural generation rate and the number of nuclei increases linearly with time until numbers are eventually limited by the agglomeration of bubbles by random motion. The number of bubbles predicted by this nucleation–agglomeration theory agrees with experimental observation in the case of uranium dioxide, but may not agree in the case of uranium, for which the re-solution parameter may not be high enough. The effect of the theoretical predictions of bubble number and size on swelling and gas migration is discussed for uranium dioxide. (auth) (UK)

32864 RADIOLYTIC REACTION BETWEEN GRAPHITE AND CARBON DIOXIDE. I. PRIMARY GASIFICATION PRODUCTS. Feates, F. S.; Walker, F. A. (Atomic Energy Research Establishment, Harwell, Eng.). Carbon; 9: 11-18(Jan 1971).

The primary gasification products of graphite oxidised radiolytically by CO_2 were measured. With ^{14}C labelled graphite conditioned by prolonged exposure to radiolysed CO_2 the ratio of CO to CO_2 rises from 0.2 at 470 to 0.5 at 770°K. The ratio is not affected by pressure (100kNm^{-2} to 2.7 MNm^{-2}) or the presence of up to 30% CO. Graphite samples not conditioned to irradiated CO_2 yield more CO, but no dependence of the ratio on the type of graphite was observed. A mechanism for gasification is proposed. (auth) (UK)

Plastics and Other Materials

Refer also to abstracts 32101, 32766, 33446, and 33447.

32865 (JUL-Bibl.-15) IRRADIATION BEHAVIOR OF PLASTICS. A Bibliography. Ekstroem, G. (Kernforschungsanlage, Juelich (West Germany)). Oct 1970. 346p. (In German and English). Dep. NTIS (U. S. Sales Only).

The 977 abstracts were taken from Nuclear Science Abstracts (NSA) Vols. 17–23 (1963–69) and Chemical Abstracts (CA) Vols. 66–69 (1966–68). The abstracts are arranged chronologically and according to chemical symbol and functional group: hydrocarbons, hydrocarbon derivatives, carbolic acid and its derivatives, amines, resins, silicones, and rubbers. The kinds of radiations considered are α, β, γ, x, neutrons, and ionizing radiations. Six indexes are included: (1) chemical names of plastics with trade names and physical properties, (2) kind of radiation, (3) trade name, (4) author, (5) patent, and (6) report. (tr-auth)

32866 CHANGE IN MICROHARDNESS OF COMMON BORATE GLASSES FOLLOWING ELECTRON IRRADIATION. Vakhromeev, V. G. (Tomsk Polytechnical Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 144-5(1970). (In Russian).

Samples of alkaline borate glasses were exposed to 1.2-MeV electrons in air at room temperature (15×10^{15} electrons/cm^2). Relative microhardness of the irradiated samples was determined with a diamond pyramid. Light absorption maxima were observed at 550, 480, and 320 nm (nanometer). The observed change of microhardness with electron bombardment is associated with color centers and destructive processes evidenced by cracks. (K.S.W.)

32867 EFFECT OF γ RAYS ON THE PRETREATMENT OF WOODS BEFORE ANALYSIS WITH A SCANNING ELECTRON MICROSCOPE. Antoine, Raymond; Van Eyseren, Jean-Claude (Univ., Louvain, Belgium). Compt. Rend., Ser. B; 272: 308-9 (1 Feb 1971). (In French).

A method permitting the observation of structural details of ligneous plants with the scanning electron microscope is described. Gamma radiation makes the wood friable and allows clean cut planes to be obtained in any direction. (auth) (France)

32868 STANDARD METHODS FOR PHYSICAL TESTING OF GYPSUM BOARD PRODUCTS AND GYPSUM PARTITION TILE OR BLOCK. ASTM C 473-68. Philadelphia; American Society for Testing and Materials (1969). 7p. Available from American Society for Testing and Materials, Philadelphia.

A standard is presented for methods for the physical testing of gypsum board products, including gypsum lath, and gypsum partition tile or block. The test methods described are used to determine: compressive strength, flexural strength, weight and thickness of paper surfacing, nail retention, board edge thickness, and water resistance. (L.C.L.)

32869 USA STANDARD: PROTECTIVE COATINGS (PAINTS) FOR THE NUCLEAR INDUSTRY. ANSI N 5.9 1967. New York; American Institute of Chemical Engineers (1968). 18p. Available from American National Standards Inst., New York.

A standard is presented which provides a common basis on which protective coatings (paints) for surfaces in a nuclear complex may be compared and selected by reproducible tests. The environmental conditions of these complexes are such that a paint may be deteriorated by exposure to any, all, or a combination of the following conditions: ionizing radiation; contamination by radioactive nuclides and decontamination processes, chemicals; immersion in highly purified water; and abrasion or wear. This standard specifically applies to the surfaces of such facilities as reactors, fuel reprocessing plants, and laboratories and hot cells. (L.C.L.)

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PHYSICS (GENERAL)

Astrophysics and Cosmology

Refer also to abstracts 33839 and 34070.

Cosmic Ray Exposure Ages

32870 METEORITES. Turner, G. (Univ. of Sheffield, Eng.). Essays Phys.; 1: 113-64(1970).

Topics discussed include meteorite falls, composition and structure, isotopic abundance variations, and orbits. 223 references. (W.D.M.)

32871 CHEMICAL FRACTIONATIONS IN METEORITES. IV. ABUNDANCES OF FOURTEEN TRACE ELEMENTS IN L CHONDRITES; IMPLICATIONS FOR COSMOTHERMOMETRY. Keays, Reid R.; Ganapathy, R.; Anders, Edward (Univ. of Chicago). Geochim. Cosmochim. Acta; 35: 337-63(Apr 1971).

A neutron-activation procedure for Ag, Au, Bi, Br, Cd, Cs, Cu, Ga, In, Pd, Rb, Te, Tl, and Zn was developed and applied to 12 chondrites (11 L3 to L6 and 1 LL3-4). Correlations between abundance and petrologic type were found for Bi, Br, Cs, In, and Tl. These elements correlated with each other and with primordial Ar and Xe. The observed inter-element correlations generally agree with calculated curves for trace element condensation from a cosmic gas at $10^{-4\pm2}$ atm. It appears that most fractionations of volatile elements, including noble gases, arose in the solar nebula rather than in meteorite parent bodies. A few elements (Cs, Br, and Tl) sometimes are overabundant in L3,4 chondrites relative to other, less volatile elements (Cu, Ga). Either these elements became enriched in the solar nebula toward the end of accretion, or they were fractionated, presumably by volatilization, in the meteorite parent bodies. Accretion temperatures of L chondrites were estimated from Bi and Tl contents. Petrologic types 3 to 6 seem to have accreted in a 100° interval centered on 530^{+80}_{-80}°K. The error quoted reflects the uncertainties in total nebular pressure ($10^{-4\pm2}$atm) and solubility of Bi and Tl in nickel–iron. Temperatures derived from Bi and Tl contents are generally concordant, as expected for the two-component model of Larimer and Anders, not for the three- and multi-component models of Tandon and Wasson and Blander and Abdel-Gawad. An equation for the fraction of In condensed ($\equiv\alpha_{In}$) was derived from the In data, using the accretion temperatures inferred from Bi and Tl contents: $\log[\alpha_{In}/(1-\alpha_{In})] = (8850 \pm 710)/T - (18.82 \pm 1.40)$. (auth) (UK)

32872 DETERMINATION OF URANIUM IN IRON METEORITES BY THE METHOD OF FISSION FRAGMENT TRACK REGISTRATION. Genaeva, L. I.; Kashkarov, L. L.; Lavrukhina, A. K. Meteoritika; No. 28, 102-6(1968). (In Russian).

The uranium content and its microdistribution were determined in samples of the Arus Yardymlinsk and Sikhote-Alin iron meteor showers by means of the fission-track method. The procedure is described. Three regions differing by about a thousand times were detected in the Sikhote-Alin samples; the distribution of uranium in Arus is more uniform. The absolute U content and the nature of its microdistribution are governed by the uniformity of the meteorite matter, and by the number and size of inclusions of accessory minerals in which uranium can be concentrated. (Geophys. Abstr.)

32873 URANIUM COSMOCHRONOLOGY. Sobotovich, E. V. Meteoritika; No. 28, 30-43(1968). (In Russian).

In connection with the discrepancy between lead-isotope ages of iron meteorites and data on the time of formation of the stony phase, it is suggested that the existence of relict cosmic bodies, survivors of the supernova explosion, is no less likely than a solar origin for meteorites. On the basis of a proposed two-stage presolar nucleosynthesis model, it is shown that the radiogenic component of lead could have developed as a result of free decay of uranium during the time between the end of uniform nucleosynthesis and the formation of the solar system, 4.7 b.y. ago. The age limit for terrestrial uranium is estimated as 4.4 to 6.6 b.y. The most probable age of iron meteorites of group II is 5.8 ± 0.2 b.y. (Geophysics Abstr.)

32874 DETERMINATION OF THE PRE-ATMOSPHERIC DIMENSIONS OF METEORITES FROM THE EFFECTS OF NUCLEAR REACTIONS PRODUCED BY COSMIC RAYS. Lavrukhina, A. K.; Ibraev, T. A. Meteoritika; No. 28, 89-95(1968). (In Russian).

The parameters affecting the accuracy of the method of determining the pre-atmospheric dimensions of iron meteorites, the extent of ablation, and location of the fragments fallen on the Earth in the parent body, on the basis of differences in depth distribution of radioisotopes with similar half lives were investigated. Possible variations in intensity of primary cosmic rays and their energy spectra at different latitudes are analyzed in detail. It is shown that the intensity and shape of the spectrum of primary cosmic rays have the greatest effect on the accuracy of determining the preatmospheric dimensions of meteorites. It is established, for example, that a 1.8-fold increase in intensity (with no change in the shape of the spectrum) leads to a 2.3-fold increase in the weight of the body. On the basis of these results, estimates of the preatmospheric radius of the body which fell as the Yardymlinsk iron meteor shower are refined and the extent of ablation is established as 75%. (Geophysics Abstr.)

32875 ISOTOPE ANOMALIES IN RARE GASES. Kuroda, P. K.; Reynolds, M. A.; Sakamoto, K.; Millar, D. K. (Univ. of Arkansas, Fayetteville). Nature (London) Phys. Sci.; 230: 42-3 (8 Mar 1971).

It was argued (Nature, 227: 1113 (1970)) that the Ne and Xe isotope anomalies observed in meteorites can be interpreted in terms of a common process of mass fractionation for both elements, but that a crucial test of the proposed mechanism should come from studies of Kr isotope anomalies. The present communication discusses a new set of Kr data from which it appears that there is a simple relationship between the abundance pattern and isotope anomalies in Ne, Ar, Kr, and Xe. A sample of the Bruderheim meteorite was used for a temperature-release experiment and samples of the Allende and Plainview, preheated at about 100°C, for total melting experiments. Isotopic compositions of Kr extracted from the Bruderheim meteorite in the temperature-release experiment are shown graphically; the results at 500 to 1,000°C suggest that the samples contain large excesses of Kr isotopes produced by cosmic rays. The general pattern of variation of the Kr isotope ratios was analogous to that for the Xe isotopes. The $^{84}Kr/^{86}Kr$ ratio varied between 3.16 (1,700°C fraction) and 3.68 (700°C fraction) corresponding to an enrichment of 1.17 for the lighter isotope in the latter fraction, as compared with an enrichment factor of 1.11 for $^{134}Xe/^{131}Xe$. It is possible that the Kr in the meteorites was a mixture of solar and planetary gas, and a partial separation of these two components should have been achieved in the temperature-release experiment. The isotopic compositions of these fractions are expected to be quite different. The extent of rare-gas isotope ratio variations can be estimated from calculations of the separation by diffusion, and enrichment results for Ke and Xe were found to be in good agreement with the values already mentioned. Calculated and observed enrichment values are tabulated for Ne, Ar, Kr, and Xe; the general agreement between the theoretical and experimental values indicated that the chief features of the rare-gas-isotope anomalies can probably be explained in terms of a mass fractionation. (UK)

Stars

Refer also to abstracts 32272, 33848, and 34164.

32876 (SC-T-713028) STELLAR ENERGY SOURCES AND THE THEORY OF STELLAR INTERIORS. Kozyrev, N. A. Translated by Fredric D. Killebrew (Sandia Labs., Albuquerque, N. Mex.), from Izv. Krym. Astrofiz. Observ.; 2: 3-43(1948). 78p. Dep. NTIS.

An attempt is made to obtain an inductive solution to the problem of stellar interiors by analyzing the laws governing observational astrophysics. The conditions of the state of matter and energy inside stars are topics for investigation and not topics for a priori assumptions. The basic laws established by observation were investigated: the ratio of "mass to absolute brightness" and the ratio of "period to mean density of the Cepheids". The results obtained from analyzing these laws were found to differ from ordinary concepts of the theory of stellar interiors. The main results were the following: (1) in all stars, even supergiants, the radiant pressure plays no substantial role and can be ignored in comparison with the gas pressure; (2) the interiors of stars consist almost totally of hydrogen (mean molecular weight near ½); (3) absorption of light is accomplished by Thomson scattering of light by free electrons; and (4) stars have a structure similar to the polytropic class ³⁄₂. The sum of the results obtained permits in first approximation computing the physical conditions inside the stars, based on the observable characteristics of L, M, R. For example, for the center of the Sun, a temperature of about six million degrees is found, this obviously being insufficient for thermonuclear reactions. (auth)

32877 TURBULENCE IN STELLAR CONVECTION ZONES. Spiegel, E. A. Comments Astrophys. Space Phys.; 3: 53-8 (Mar-Apr 1971).

Formerly the prescription used to calculate the structure of convection zones was to set the temperature gradient equal to its adiabatic value wherever convective instability arose. Öpik and Böhm pointed out that this procedure is not adequate for stellar envelopes since radiative effects become strong at the outer edges of the zones. Though the old prescription is still used for core convection, the version of mixing-length theory introduced by Böhm is now widely used for outer convection zones. The questions discussed here are whether, in the limit of very strong convection, the two procedures are equivalent and, if not, whether the difference is of concern. (W.D.M.)

32878 SOME COMMENTS ON SUPERMETALLICITY. Spinrad, Hyron; Taylor, Benjamin J. (Univ. of California, Berkeley). Comments Astrophys. Space Phys.; 3: 40-7(Mar-Apr 1971).

Since the publication of Spinrad and Taylor (Astrophys. J.; 157: 1279(1969)), much of the attention given to supermetallicity and the scanner abundance technique has been directed at three major problems: the abundances of M67 and NGC 188, the abundance of δ Pav, and the discrepancies between the results of different analyses of the same stars. The present status of each of these problems is discussed. (W.D.M.)

32879 INTERSTELLAR ABSORPTION AND COLOR EXCESSES IN SCO OB-1. Schild, R. (Smithsonian Astrophysical Observatory, Cambridge, Mass.); Neugebauer, G.; Westphal, J. A. Astron. J.; 76: 237-41(Apr 1971).

New spectral types and photometry are reported for numerous stars in Sco OB-1 and in the foreground of the association. The new data permit reddening in the local spiral arm to be subtracted out in a discussion of reddening in the gas and dust of an adjacent spiral arm. The reddening that occurs within the association Sco OB-1 itself appears to be normal and to have R = 3. Infrared fluxes indicate no deviations (in the reddening law from the ultraviolet to 2.2 μ) from the law for the local spiral arm in Scorpio. The new data show no evidence for a recently reported correlation between absolute magnitude and color excess. (auth)

32880 H–R DIAGRAM OF THE ALPHA PERSEI CLUSTER. Morgan, W. W. (Univ. of Chicago); Hiltner, W. A.; Garrison, R. F. Astron. J.; 76: 242-5(Apr 1971).

A new H–R diagram of the Alpha Persei cluster is given from 106 members identified by Heckmann and Lubeck; the slit spectrograms were obtained at the McDonald Observatory. A revised classification for the F0–G2 stars, based on the intensity of arc metallic lines, was used. The resulting diagram shows: a narrow main sequence from B3 to F0; a remarkably sharp lower edge of the main sequence between F2 and G0; a "helium-weak" star; and a peculiar A star whose spectrum on low-dispersion plates resembles that of ϵ UMa. There is evidence for peculiarities in the spectra of some F stars (H lines and G band); however, the reality of the peculiarities will have to be confirmed from new spectrograms. (auth)

32881 STANDARD STARS FOR THE FIVE-COLOR PHOTOMETRIC SYSTEM OF THE DOMINION ASTROPHYSICAL OBSERVATORY. Hill, G. (Dominion Astrophysical Observatory, Victoria, B. C.); Morris, S. C.; Walker, G. A. H. Astron. J.: 76: 246-51(Apr 1971).

Forty-nine stars uniformly distributed in right ascension and north of declination −10° were observed over the last two years an average of 40 times each in the five-color system developed at the Dominion Astrophysical Observatory. The colors are measured with a simultaneous, four-channel photometer which isolates the Balmer continuum (35), the higher members of the Balmer series (38), regions matching the B (44) and V (54) filters of Johnson and Morgan, and two regions (42 and 56) formed by masking half of the 44 and 54 regions. The stars form an unreddened spectral sequence from O9 to K7 and the observations were reduced to a self-consistent system. The standard values of the colors are presented together with the transformation of c(44 − 54), B − V. The zero points for the c(35 − 44), c(38 − 44), and c(38 − 42) colors were set at the minima in the plots of these colors against B − V near B − V = 0. The standard deviation of the adopted means for each color is generally about 0.002m. Results for cluster sequences and program stars will be presented in later papers together with detailed discussions of the astrophysical significance of the colors. (auth)

32882 PHOTOMETRIC OBSERVATIONS OF THE STAR CLUSTER NGC 6819. Burkhead, Martin S. (Indiana Univ., Bloomington). Astron. J.: 76: 251-9(Apr 1971).

Photoelectric and photographic observations are presented for the open cluster NGC 6819. The data indicate the cluster is old with a main-sequence turnoff near that of M67. The color–magnitude diagram indicates a break in the main-sequence turnoff at $M_V \cong 3.9$, (B − V) = 0.50, a populated Hertzsprung gap, and a well-defined rising giant branch terminating at $M_V = -0.5$, (B − V) = 1.6. With an assumed E(B − V) = 0.12 and $R_V = 3.0$, the distance modulus is 11.55. (auth)

32883 OBSERVATIONS OF STARS IN H II REGIONS: SPECTRAL CLASSIFICATION AND UBV PHOTOMETRY. Crampton, David (Dominion Astrophysical Observatory, Victoria, B. C.). Astron. J.: 76: 260-4(Apr 1971).

UBV photometry and spectral types are presented for stars that may be the exciting stars of H II regions in the southern hemisphere. Attention is drawn to stars that belong to five open clusters and also to possible Wolf–Rayet members of the clusters. (auth)

32884 OBSERVATIONS OF λ4430 IN REFLECTION NEBULAE. A'Hearn, Michael F. (Univ. of Maryland, College Park). Astron. J.; 76: 264-8(Apr 1971).

Narrow-band filters were used to isolate the diffuse interstellar feature at 4430 Å. Observations of three reflection nebulae indicated that, in both NGC 1435 (Merope) and IC 2177, the feature is formed within the nebula while it does not seem to be formed within IC 432. (auth)

32885 COMPARISON OF THE TWO-MICRON SKY SURVEY WITH THE DEARBORN CATALOG OF FAINT RED STARS. Grasdalen, Gary L.; Gaustad, John E. (Univ. of California, Berkeley). Astron. J.; 76: 231-6(Apr 1971).

By use of the Dearborn Catalog of Faint Red Stars, 93% of the infrared sources in the Two-Micron Sky Survey, in the declination range in which the two catalogues overlap, can be identified with known stars. Of the remaining unidentified objects, some are likely to be red variable stars, others highly reddened supergiants in the galactic plane, and a few possibly peculiar objects associated with dense dust clouds. (auth)

32886 OSCILLATIONS OF THE FERMI FLUID IN A GRAVITATIONAL FIELD. Akhiezer, I. A.; Barts, B. I. (Physical-Technical Inst., Kharkov). Ukr. Fiz. Zh.; 15: 1709-20(Oct 1970). (In Russian).

The properties of a system of Fermi particles (Fermi fluid) were studied in a gravitational field. Apparently, neutron stars may be considered as such a system. The equilibrium distribution of the Fermi fluid in a gravitational field (the barometric formula for the Fermi fluid) was found. Hydrodynamic equations describing low-frequency motions of such a system were derived. Collective oscillations of the Fermi fluid in a gravitational field were investigated. It is shown that two zero-sound modes and two common sound modes may propagate in it. Under certain conditions growth of common sound may occur. If such growth takes place in a neutron star, it must lead to turbulent phenomena in the external strata of the star. (auth)

32887 IS THERE A BLACK HOLE IN ϵ AURIGAE. Demarque, P. (Yale Univ., New Haven); Norris, S. C. Nature (London); 230: 516-17(23 Apr 1971).

It has been suggested that the secondary component of this eclipsing binary system is a "black hole" and the result of a stellar implosion. Current interest in the physics of black holes and research in the dynamics of supernova phenomena, indicating that collapsed objects may be quite common in the galaxy, make this suggestion very interesting. The reasoning behind the suggestion is as follows: (a) the primary F supergiant is in a post-main-sequence stage of evolution, and (b) as a consequence of (a) the secondary must originally have been the more-massive component of the system; it must have evolved faster and is now observed as a "black hole" after losing much of its mass as a supergiant. Statement (a) is probably correct, but it does not follow that the secondary was originally the more-massive component. The observational evidence appears to indicate that the secondary is the less-massive star of the system and that mass transfer from primary to secondary is proceeding at present, resulting in the formation of a disk of matter about the secondary. Lines of evidence supporting the hypothesis of mass transfer from primary to secondary are discussed. There is evidence that the disk has a photospheric region with a temperature ~4,000 K and, hence, is composed of opaque hot gas. There is also evidence that the outer part of the disk is excited not by the F star but by its own photosphere, and the disk must therefore be heated from inside. The disk will be 2.3 magnitudes fainter than the F star in the visual and, therefore, difficult to observe outside eclipse. The observational constraints on the secondary are all satisfied by an ordinary main-sequence O star. It is believed that when all the relevant data are taken into account there is no compelling evi-

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dence for a "black hole" in the system, and an alternative model is proposed. (UK)

32888 UBV PHOTOMETRY OF THE REFLECTION NEBULA CED 201. Racine, Rene (Carnegie Institution of Washington, D. C. California Inst. of Tech., Pasadena). Astron. J.; 76: 321-3(May 1971).

Photoelectric UBV photometry of 33 regions of Ced 201 is reported. The colors of the nebula are found to define a standard reddening line in the two-color diagram. The illuminating star BD + 69° 1231 is shown to be located in front of the dust cloud and the albedo of the scattering particles appears to be constant in all three bandpasses of the UBV system. Finally, it is suggested that the dust cloud is highly homogeneous and that a very realistic geometrical model could be produced with a minimum of arbitrary parameters. (auth)

32889 ACCURATE LOW-DISPERSION LUMINOSITY INDICATOR FOR LATE F AND EARLY G DWARFS. Barry, Don C. (Univ. of Southern California, Los Angeles). Astron. J.; 76: 324-30(May 1971).

Visual estimates of the 3859 Å/3871 Å ratio at MK dispersion (grating spectra) indicate absolute magnitudes with an accuracy equal to or better than previous spectroscopic or photometric techniques. For 23 stars, comparison of the Strömgren indices Δc_1, $\Delta c_1{}^*$, and the 3859 Å/3871 Å ratio with absolute visual magnitudes obtained from trigonometric parallaxes and V photometry gives probable errors of plus or minus 0.22, 0.20, and 0.19 mag, respectively. The ratio is not affected seriously by differences in metallic line strength nor by interstellar reddening. Because of the moderately low dispersion required, the criterion should yield accurate spectroscopic parallaxes up to an apparent distance modulus of nine magnitudes in one hour with a 150-inch telescope. Electronic aids might further increase this range. (auth)

32890 C-M DIAGRAM OF M12. Racine, Rene (Univ. of Toronto). Astron. J.; 76: 331-4(May 1971).

Photoelectrically calibrated B, V photographic photometry to 18.5 mag is reported for over 1000 stars in a 13 arc min diameter field centered on the globular cluster M12. The color–magnitude diagram was found to be similar to the one for M13. Attention is drawn to a "gap" in the blue end of the horizontal branch. The reddening is estimated at $E(B-V) = 0.17 \pm 0.03$ and the distance modulus is $(m-M)_0 = 13.8 \pm 0.15$ [$M_V(RR) = +0.6$]. (auth)

32891 UPGREN'S UNCLASSIFIED STARS: A NEW TYPE OF G-GIANT STAR? Sturch, C.; Helfer, H. L. (Univ. of Rochester, N. Y.). Astron. J.; 76: 334-8(May 1971).

UBVRI photometry is presented for 17 stars near the north galactic pole for which Upgren (1962) could not obtain luminosities. While their UBV colors are similar to dwarfs, the position of these stars in the U – B, R – I diagram matches none of the following: (i) Hyades and nearby field dwarfs, (ii) field giants with r < 100 pc, (iii) M67, and (iv) the giant branches of a variety of globular clusters. Spectrograms indicate that they are giants and analysis of proper motions hints that they belong to the halo population. It is noted that the very hottest of Upgren's giants also possess similar properties to those of Upgren's unclassified stars. (auth)

32892 FINDING LIST OF EARLY-TYPE STARS NEAR THE SOUTH GALACTIC POLE. Slettebak, Arne; Brundage, Richard K. (Ohio State Univ., Delaware. Ohio Wesleyan Univ., Delaware). Astron. J.; 76: 338-62(May 1971).

An area of 840 deg^2 centered at the south galactic pole was covered with objective-prism plates taken with the Michigan Curtis Schmidt telescope at the Cerro Tololo Inter-American Observatory for the purpose of segregating stars of early type. A total of 957 stars of spectral type B to F0 were found to a limiting magnitude between 14 and 15, plus a number of peculiar stars of later type and three galaxies showing emission lines. Positions, magnitudes, and spectral types are given for all stars, with finding charts for those not listed in the BD or CD catalogues plus a few faint CD stars. (auth)

32893 SPECTROGRAPHIC STUDY OF THE β CEPHEI STAR ν ERIDANI. Laskarides, P. G.; Odgers, G. J.; Climenhaga, J. L. (Univ. of Victoria, B. C.). Astron. J.; 76: 363-74(May 1971).

A spectrographic study of the β Cephei star ν Eridani was made using 68 high-dispersion (6.5 Å mm^{-1}) spectrograms obtained with the coudé spectrograph of the 48-inch telescope of the Dominion Astrophysical Observatory. A small variation in the equivalent widths of the hydrogen lines suggests a variation pattern with a possible filling in at the phase of maximum stellar radius. This emission is a consequence of the enormous atmosphere at that phase. The profiles of the Si III lines λλ 4553, 4568, and 4575 Å were found to vary with the phase. The lines were broader and shallower at minimum radius and sharper and deeper at maximum radius, although the strength of the lines remained almost unchanged. The same variation pattern was observed in the O_{II} and He_I lines. There also appeared to be a relation between the phases at which the sharper lines occur and the wavelengths of the lines. There is no evidence that a "van Hoof effect" exists in this star. (auth)

32894 NEUTRON STARS. Kisdi, David (Theoretical Physics Research Group, Sofia). Fiz. Szemle; 21: 17-20(Jan 1971). (In Hungarian).

Modern methods of observation of astronomy show promise to clarify the problem of the potential existence of stars consisting only of neutrons. Solution of concentration and mass density equations indicate that in the case of $n \gtrsim 10^{34}$ nucleons/cm^3, matter consists only of neutrons; the concentration of the $p + e^-$ pairs is then lower than 10^{-4}. In that case, the neutrons cease to exhibit β decay and become stable components of the matter. The upper limit of the neutron matter density was calculated at $n \gtrsim 10^{40}$ neutrons/cm^3, because in that case $n + n \rightarrow p + \Sigma^-$ decay takes place. The internal structure of neutron stars is described on the basis of the usual hydrostatic equations, assuming that at time T = 0, the star has spherical symmetry, does not rotate and is in a static equilibrium state. A concrete determination of the structure requires knowledge of the energy of the neutron mass as a function of density, as handled in the form of a quantum-mechanical many-body problem. The problem is complicated by the consideration of nuclear forces. The calculations indicate that the radius of stable neutron stars is R = 102 km; their mean density is close to that of the nucleus and their mass is of the same order of magnitude as the mass of the Sun. Gold's model of neutron stars possessing rotational and magnetic energy is also described. (TTT)

32895 TIME-DEPENDENT PERTURBATION OF A RELATIVISTIC LIGHT SOURCE. Klotz, A. H.; Bicknell, G. V. (Univ. of Sydney). Acta Phys. Pol.; A39: 113-25(Feb 1971).

A model of a time-dependent, relativistic light source is discussed using perturbation techniques of Thorne. The interior solution corresponds to a pulsating star, for which the energy momentum tensor is the perturbed tensor of a perfect fluid. All perturbations are assumed to be harmonic in time. (auth)

32896 EFFECTIVE TEMPERATURES, INTRINSIC COLOURS, AND SURFACE GRAVITIES OF YELLOW SUPERGIANTS AND CEPHEIDS. Parsons, Sidney B. (Case Western Reserve Univ., Cleveland). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 121-31 (1971).

Effective temperatures, surface gravities, and color excesses of supergiant stars in the spectral range F_3-G_3 are obtained by matching UVBGRI photometry with model atmosphere fluxes. Effective temperatures and surface brightnesses correlate very well with derived intrinsic B – V colors (UBV system) and confirm Kraft's widely-used $T_e - (B-V)_0$ relationship. Mean values of T_e, $(B-V)_0$, log g, and B. C. are given as functions of spectral class. There is very little overlap in the log g – T_e plane between the pulsating and nonpulsating stars. Order-of-magnitude variations in surface gravity are found for many Cepheids which follow more closely the temperature and velocity variations than the dynamical accelerations of the atmospheres. Schwarzschild's running-wave hypothesis is revived in order to account for the behavior of the effective surface gravity. (auth) (UK)

32897 RADII, LUMINOSITIES, AND MASSES FROM SIX-COLOUR FITTING OF GALACTIC CEPHEIDS AND OTHER SUPERGIANTS. Parsons, Sidney B.; Bouw, Gerardus D. (Case Western Reserve Univ., Cleveland). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 133-44(1971).

The angular diameters and surface gravities derived for pulsating and nonpulsating yellow supergiants from comparison of observed and computed UVBGRI photometry are generally consistent with previous absolute magnitude and radius values as well as evolutionary calculations without mass loss; together they yield refined estimates of the basic physical properties of these stars. Fernie's hypothesis of overtone pulsation for several Cepheids is more consistent than fundamental pulsation is with the data for these stars. Values of the pulsation constant Q show a gradual increase with increasing period. Good correlations of radius with period and surface brightness with $(B-V)_0$ yield a period–luminosity–color relationship. (auth) (UK)

32898 COMPOSITE SPECTRUM OF γ CIRCINI. Buscombe, William; Barkstrom, Bruce (Northwestern Univ., Evanston, Ill.). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 37-45(1971).

High-dispersion spectrograms (150 μ A^{-1} in the blue, 100 μ A^{-1} in the yellow–red) for γ Cir, secured at Mount Stromlo in 1966–67, were analysed from direct intensity tracings. In the

violet, an almost pure B_5 spectrum is seen. The long-wavelength region is dominated by the sharp absorption lines of the F8 V star, for which a curve of growth was constructed. With solar log η_0's, a good fit to Wrubel's theoretical curve is obtained with $T_{exc} = 5700°K$ and a microturbulent velocity of 1.0 km s^{-1} for Ca I, Fe I, Fe II, and Ni I. The increasing contribution of the F star to the combined light from Hϵ to Hβ is estimated from the ratio of strengths of the metallic absorption lines to the solar values. The lack of evidence of any variation in light or radial velocity (–17 km s^{-1} for both components) is consistent with the interpretation as an optical double of 1″ separation with counter-clockwise relative motion. (auth) (UK)

32899 ATMOSPHERES OF WHITE DWARFS. III. THE LINE SPECTRA. Strittmatter, P. A.; Wickramasinghe, D. T. (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 47-73(1971).

Model atmospheres with temperatures in the range $10,000° \leq T_{eff} \leq 25,000°K$ and with gravities $6 \leq \log (g) \leq 9$ were constructed for various helium abundances with a view to understanding the spectra of the hotter white dwarfs. The roles of accretion, convection, circulation, gravitational diffusion, and magnetic fields were also examined. It is shown that the DB stars are confined to the temperature range $15,000° \leq T_{eff} \leq 18,000°$ in which convection also becomes important in the outer layers of a helium rich star. The DA stars seem to avoid this temperature range. The hydrogen and metal abundances in DB atmospheres are shown to be reduced by factors 10^5 and 10^3 respectively compared to solar values. Possible explanations of DC spectra are also discussed. (auth) (UK)

32900 RED SPECTRUM OF Grw + 70°8247. Wegner, Gary (Univ. of Washington, Seattle). Publ. Astron. Soc. Pac.; 83: 205-6(Apr 1971).

The spectrum of the high magnetic-field white dwarf, Grw + 70°8247, is discussed. Two new features near 5692 and 5852 Å are reported. (auth)

32901 MASS AND ABSOLUTE MAGNITUDE OF THE VISUAL BINARY DELTA EQUULEI FROM RADIAL VELOCITY OBSERVATIONS. Dworetsky, M. M.; Popper, D. M.; Dearborn, D. S. (Univ. of California, Los Angeles). Publ. Astron. Soc. Pac.; 83: 207-9(Apr 1971).

It was determined that the average component of δ Equ has a mass $\mathcal{M} = 1.23 \pm 0.08\ \mathcal{M}_\odot$ and an absolute magnitude $M_V = +4.0 \pm 0.1$. This determination is based on new observations of the system as a spectroscopic binary combined with data from the visual orbit. (auth)

32902 PARALLAX OF THE LARGE PROPER-MOTION STAR G158-27. Riddle, R. K.; Behall, A. L.; Guetter, H. H.; Christy, J. W. (Naval Observatory, Washington, D. C.). Publ. Astron. Soc. Pac.; 83: 210(Apr 1971).

The results of a preliminary parallox and proper motion solution for G158-27 are summarized. (W.D.M.)

32903 PHOTOELECTRIC OBSERVATIONS OF AH TAURI. Bookmyer, Beverly B. (Univ. of Arizona, Tucson). Publ. Astron. Soc. Pac.; 83: 211-12(Apr 1971).

Photoelectric observations of AH Tauri were obtained with B and V filters on two nights; an epoch of minimum light and improved light elements are given. (auth)

32904 OPEN CLUSTER NGC 4609 BEHIND THE COALSACK. Feinstein, A.; Marraco, H. G. (Univ. Nacional de La Plata, Argentina). Publ. Astron. Soc. Pac.; 83: 218-21(Apr 1971).

Photoelectric observations in the UBV system are given for stars in and near the open clusters NGC 4609 and Hogg 15. NGC 4609 is at a distance of 1320 pcs and it is 6×10^7 years old. The spread of stars around its main sequence is larger than in other clusters and this may be related with the absorbing material of the Coalsack. (auth)

32905 MOLECULAR RATIOS SENSITIVE TO ELEMENTAL ABUNDANCES. Virgopia, N. (Osservatorio Astronomico, Rome); Vardya, M. S. Publ. Astron. Soc. Pac.; 83: 222-6(Apr 1971).

A large number of molecular ratios, which are sensitive to relative elemental abundances of H, C, N, and O were determined. The calculations were carried out over a wide range of temperature and pressure and for several chemical compositions. (auth)

32906 ABSOLUTE PROPER MOTIONS FOR 41 RR LYRAE STARS. Klemola, A. R. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac.; 83: 227-9(Apr 1971).

Absolute proper motions for 41 RR Lyrae stars in 16 fields lying outside the zone of avoidance were measured in a pilot proper-motion program. The mean error of a single component of stellar proper motion, measured with respect to an average of 50 galaxies per field, was 0.7″ per century. Motions were compared with van Herk and with Clube, but a meaningful study of the systematic differences was prevented by the small number of common stars. (auth)

32907 OBSERVATIONS OF EIGHT SUSPECTED VARIABLE STARS. Wirtanen, C. A.; Klemola, A. R. (Univ. of California, Santa Cruz). Publ. Astron. Soc. Pac.; 83: 230-1(Apr 1971).

Eight probable new variable stars of magnitudes 13 to 18 were found from a comparison of Lick 20-inch astrographic photographs taken for the pilot proper-motion program. (auth)

32908 MASS EXCHANGE AND THE BETA CEPHEI STARS. Plavec, Miroslav (Univ. of California, Los Angeles). Publ. Astron. Soc. Pac.; 83: 144-8(Apr 1971).

Statistical considerations indicate that a nonnegligible fraction of apparently single main-sequence stars earlier than A5 should actually be the more massive components of binaries in which a large-scale mass exchange has occurred (van den Heuvel 1969). It is rather difficult to identify these objects. If the μ mechanism as proposed by Stothers and Simon (1969) were the correct explanation of the β Cephei phenomenon, then this phenomenon would identify one class of these transformed binaries. From known models of mass exchange, some conditions are derived that should be fulfilled by binaries if they are to display the μ mechanism. Most of the stars in the list by Stothers and Simon (1970) do not seem to meet these conditions. If some of them are found to be β Cep variables, then either the μ mechanism or the models of mass exchange will have to be revised. It is suggested that certain peculiar binaries and shell stars (and possibly also symbiotic variables) are binaries observed at the stage of mass exchange or mass loss. (auth)

32909 SPECTROSCOPIC OBSERVATIONS OF THE VISUAL BINARY Σ2173 (ADS 10598). Batten, A. H. (Dominion Astrophysical Observatory, Victoria, B. C.); Fletcher, J. M.; West, F. R. Publ. Astron. Soc. Pac.; 83: 149-53(Apr 1971).

The suspected resolution of the spectra of the components of the visual binary star Σ2173, which West reported in 1966, was confirmed on five high-dispersion (2.5 Å/mm) spectrograms obtained at Victoria in 1968 and 1969. In 1968, the radial-velocity difference was about 10.6 km/sec. West's original measures are revised and discussed, together with the new data. The magnitude difference, by Petrie's method, from two of the Victoria spectrograms is $\Delta m = 0.029 \pm 0.004$m. The adopted masses are 1.14⊙ and 1.08⊙. The node at 153° position angle is identified as the ascending node. (auth)

32910 M4-307, A STAR ABOVE THE HORIZONTAL BRANCH? Philip, A. G. Davis (Dudley Observatory, Albany. State Univ. of New York, Albany). Publ. Astron. Soc. Pac.; 83: 154-5(Apr 1971).

Four-color and Hβ photometry of M4-307, a star located above the horizontal branch in the color–magnitude diagram of M4, shows that it is a foreground object with a spectral type of F4. A spectrum obtained with the Carnegie image tube on the 84-inch telescope confirms the spectral type. The radial velocity measured from the spectrum is –26 km/sec, which is quite different from the cluster velocity of +65 km/sec. (auth)

32911 OCCULTATION STUDIES AT THE DOMINION ASTROPHYSICAL OBSERVATORY. Morbey, C. L.; Hutchings, J. B. (Dominion Astrophysical Observatory, Victoria, B. C.). Publ. Astron. Soc. Pac.; 83: 156-61(Apr 1971).

Observations of lunar occultations were made with a time resolution of one millisecond at the Dominion Astrophysical Observatory. A computer program was written that compares theoretical and observed diffraction patterns and gives a least-squares best fit in terms of the angular diameter of the star and the slope of the lunar limb. (auth)

32912 IDENTIFICATION OF TECHNETIUM IN STELLAR SPECTRA. Peery, Benjamin F. Jr. (Indiana Univ., Bloomington). Publ. Astron. Soc. Pac.; 83: 162-5(Apr 1971).

Arguments in favor of the correctness of the identification of technetium in stellar spectra are: (1) wavelength coincidences and relative strengths compared with the 13 strongest laboratory Tc lines in the violet; (2) preservation of the proper relative strengths among the lines from star to star, irrespective of the prominence or faintness of the set; (3) the appearance of lines identified with Tc only in stars with over-abundant s-process elements that peak near the neutron magic number 50. (auth)

32913 MEASUREMENT OF STRONG PLANETARY NEBULAE AT SHORT CENTIMETER WAVELENGTHS. Hobbs, R. W.

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(Naval Research Lab., Washington, D. C. Goddard Space Flight Center, Greenbelt, Md.); Waak, J. A. Publ. Astron. Soc. Pac.; 83: 166-9(Apr 1971).

Planetary nebulae IC 418, NGC 6857, and NGC 7027 were measured at 2.73, 1.65, and 0.95-cm wavelengths. Flux densities were measured by reference to Jupiter. The source near NGC 6857 is extended and has the spectrum to be expected from a composite thermal source. The spectrum is nearly flat near 1 cm, indicating that all components have become optically thin by this wavelength. NGC 7027 and IC 418 have typical thermal spectra, and are optically thin at all three wavelengths. (auth)

32914 SPECTRUM AND LUMINOSITY OF AG AND HR CARINAE. Viotti, R. (Laboratoria di Astrofisica Spaziale, Frascati, Italy). Publ. Astron. Soc. Pac.; 83: 170-2(Apr 1971).

The photometric and spectroscopic observations of the P Cygni-type stars AG and HR Carinae are discussed, and compared with η Car and P Cyg. It is concluded that both are very luminous stars suffering large mass loss. (auth)

32915 VARIATION OF METAL ABUNDANCE IN STARS IN POPULATION I CLUSTERS. Hesser, James E. (Observatorio Interamericano de Cerro Tololo, La Serena, Chile); Henry, Richard C. Publ. Astron. Soc. Pac.; 83: 173-6(Apr 1971).

Narrow-band photoelectric photometry of the K line of calcium was obtained for the A stars of five galactic clusters. The 38 stars measured in NGC 6475 (M7) exhibit a range in calcium abundance of only ±25%, rather than the factor-of-two variation observed for field stars. This suggests that the interstellar cloud from which NGC 6475 was formed was similarly homogeneous in calcium and, presumably, other metals. In addition, suspected metallic-line stars in NGC 6475, IC 2391, the Hyades, and the Pleiades are mentioned. (auth)

32916 UBV PHOTOMETRY OF 173 PZT STARS. Walker, R. L. Jr. (Naval Observatory, Flagstaff, Ariz.). Publ. Astron. Soc. Pac.; 83: 177-83(Apr 1971).

Photoelectric UBV photometry for 173 PZT stars was completed, and the results are presented. These observations complete UBV photometry for stars in the PZT catalogs used by the U. S. Naval Observatory. (auth)

32917 PHOTOMETRY OF THE ECLIPSING STAR ZZ BOOTIS. McNamara, D. H.; Hansen, H. K.; Wilcken, S. K. (Brigham Young Univ., Provo, Utah). Publ. Astron. Soc. Pac.; 83: 192-8(Apr 1971).

Analysis of photometric observations of the sharp-line, F2 eclipsing binary ZZ Bootis is reported. The light curve exhibits two practically identical partial eclipses that are used to derive photometric elements. Narrow- and intermediate-band photometry are combined with the photometric and spectroscopic elements to derive accurate radii, masses, surface gravities, absolute magnitudes, and color indices of the two stars. (auth)

32918 MILLIMETER WAVELENGTH SPECTRUM OF TAURUS A. Zabolotni, V. F.; Sholomitskii, G. B.; Slysh, V. I. (Sternberg State Astronomical Inst., Moscow). Astrophys. Lett.; 8: 1-2(Mar 1971).

Measurements of Taurus A (the Crab Nebula) in the wavelength range 1 to 5 mm were made in July 1969 and May 1970 with an indium antimonide detector at the prime focus of the 22-m radio telescope in the Crimea. No significant far-infrared excess, as reported by Beckman et al. (1969), was found. The measured flux density at λ_{av} = 2.5 mm was found to be 255 ± 80 flux units. This value fits or is in agreement with the straight power-law spectrum of index −0.26 determined at longer wavelengths. (auth)

32919 PHOTOMETRY OF THE RAPID VARIABLE STAR, HDE 310376. Hiltner, W. A.; Gordon, M. F. (Univ. of Michigan, Ann Arbor). Astrophys. Lett.; 8: 3-4(Mar 1971).

Further photometry of the peculiar star HDE 310376 is shown and briefly discussed. (auth)

32920 BETA-PROCESSES IN EXPLODING STARS. Barkat, Zalman; Buchler, Jean-Robert; Wheeler, J. Craig (California Inst. of Tech., Pasadena). Astrophys. Lett.; 8: 21-5(Mar 1971).

Beta processes on material in nuclear statistical equilibrium, such as would be found in the aftermath of a thermonuclear detonation in a highly evolved stellar core, may induce the formation of a remnant. Previous work has shown that β-processes on free nucleons (only) will have important dynamical effects on stars that undergo detonations at central densities greater than $\sim 10^{10}$ g/cm^3. That work is now extended by including β-processes on nuclei. Adopting 50 msec as a representative timescale for changes in density, a critical density $\rho_{crit} \sim 6 \times 10^9$ g/cm^3 is found above which β-processes in the detonated material will cause significant pressure decreases in a comparable time. Stars which undergo detonation at a central density $\rho \gtrsim \rho_{crit}$ are then fated to leave a remnant. The nature of "β-kinetic equilibrium" (BKE) is also examined and it is concluded that the use of BKE β-process rates in a dynamical situation cannot be justified. (auth)

32921 SHELL SPECTRUM OF 48 LIBRAE DURING THE PERIOD 1962–1970. Faraggiana, R. (Astronomical Observatory, Trieste, Italy. Haute Provence Observatory, France). Astrophys. Lett.; 8: 45-7(Mar 1971).

Studies of high-dispersion spectra (9.7 Å/mm) of the variable 48 Librae show that the ten-year period no longer holds, since the last minimum occurred in 1967–1968 instead of 1965 as expected. Qualitative remarks on the line variation are given. (auth)

32922 IMPORTANCE OF SPECTRAL LINE SHAPES IN ASTROPHYSICS. Pagel, B. E. J. (Royal Greenwich Observatory, Herstmonceux, Eng.). J. Phys., B (London); 4: 279-87 (1971).

The following applications of spectral-line broadening theory to astrophysics are briefly reviewed: (i) understanding qualitative affects visible on spectrograms; (ii) quantitative understanding of hydrogen-line profiles for the determination of stellar atmospheric parameters; (iii) effects of line broadening on the determination of stellar chemical composition. (auth) (UK)

32923 SILICON MONOXIDE IN THE INFRARED SPECTRUM OF ALPHA ORIONIS. Cudaback, D. D. (Univ. of California, Berkeley); Gaustad, J. E.; Knacke, R. F. Astrophys. J.; 166: No. 2, L49-51(1 Jun 1971).

The first-overtone vibration–rotation band of SiO was detected in the 4-μ spectrum of α Ori. (auth)

32924 ENERGY TRANSPORT IN STELLAR WINDS. Barnes, Aaron (Ames Research Center, Moffett Field, Calif.); Hartle, R. E.; Bredekamp, J. H. Astrophys. J.; 166: No. 2, L53-8 (1 Jun 1971).

Models of stellar-wind flow are described in which the energy transport is associated with both (1) propagation and dissipation of hydromagnetic waves originating near the stellar surface, and (2) heat conduction. Fixed boundary conditions appropriate for the Sun are used to generate a series of models by varying the wave intensity at the base of the corona. For a range in which most observed solar-wind velocities lie, this series of models quantitatively predicts the previously unexplained correlation between flow speed and proton temperature at 1 A.U. (auth)

32925 CAUSE OF THE REDSHIFTS IN WHITE-DWARF SPECTRA. Wiese, W. L.; Kelleher, D. E. (National Bureau of Standards, Washington, D. C.). Astrophys. J.; 166: No. 2, L59-63(1 Jun 1971).

Detailed laboratory measurements of the profiles of some Stark-broadened Balmer lines reveal systematic slight shifts of these lines to the red, which are linear functions of the electron density. It appears that the Stark-induced redshift accounts for a portion of the observed redshift in white dwarfs that has previously been attributed entirely to gravitation. (auth)

32926 GRAVITATIONAL WAVES IN THE EVOLUTION OF THE BINARY WZ SAGITTAE. Vila, S. C. (Univ. of Pennsylvania, Philadelphia). Nature (London) Phys. Sci.; 230: 39(8 Mar 1971).

Nova WZ Sagittae is an eclipsing binary with one of the shortest-known periods. The author employs the realistic equation of state for cold matter developed by Zapolski and Salpeter (Astrophys. J., 158: 809(1969)) to calculate the present state and evolution of this system, with inclusion of loss of angular momentum by gravitational radiation. (UK)

32927 PHYSICAL PARAMETERS OF TWO PLANETARY NEBULAE WITH WOLF–RAYET NUCLEI. Van Blerkom, David J. (Univ. of Massachusetts, Amherst). Astrophys. J.; 166: No. 2, 343-8(1 Jun 1971).

The hypothesis that planetary nuclei and Wolf–Rayet stars of the same spectral type are scaled versions of each other is applied to the planetary nebulae BD + 30°3639 and NGC 40. When corrected observational data are used, all the physical parameters derived for BD + 30°3639 are consistent with the known properties of planetary nebulae and Wolf–Rayet stars. BD + 30°3639 is found to be a compact object at an early phase of the planetary-nebula stage. NGC 40, on the other hand, is found to be about 10 times larger and more massive than BD + 30°3639–a value which indicates a nebula near the end of the planetary stage. The central stars of the two nebulae are very similar.(auth)

32928 FAR-ULTRAVIOLET SPECTRA AND PHOTOMETRY OF PERSEUS STARS. Carruthers, George R. (Naval Research

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Lab., Washington, D. C.). Astrophys. J.; 166: No. 2, 349-59 (1 Jun 1971).

Far-ultraviolet spectra in the range 1000 to 1500 Å and photometric data in the ranges 1050 to 1180 and 1225 to 1350 Å were obtained for several early-type stars in Perseus in an Aerobee rocket flight March 13, 1970. The spectra of ϵ Per and ξ Per are consistent with expectations based on previous observations of stars having similar spectral classifications. The photometric results, when corrected for interstellar reddening, are consistent with expectations for ϵ and ζ Per, but ξ Per and a few other stars observed appear to be up to 1 mag brighter in the far-ultraviolet, relative to the visible, than expected. The present data do not allow a firm determination as to whether this is due to local variations in the interstellar extinction curve or to the stars being intrinsically brighter than predicted by model-atmosphere theory. (auth)

32929 FORBIDDEN TRANSITIONS IN THE C I SEQUENCE. Nussbaumer, H. (Univ. of Colorado, Boulder). Astrophys. J.; 166: No. 2, 411-22(1 Jun 1971).

Transition probabilities for most of the astronomically significant members of the C I sequence for the transitions within the ground configuration are presented. For O^{2+} the total intensity of all transitions, the intensity of $^1D_2 \rightarrow {}^3P_2$ (λ5007.57), and the ratio of intensities $^1S_0 \rightarrow {}^1D_2 : {}^1D_2 \rightarrow {}^3P_2$ are tabulated as a function of N_e and T_e. For determinations of T_e in planetary nebulae, differences between present calculations and those made with former transition probabilities become noticeable for $N_e > 10^4$. For a given value of the observed intensity ratio, the deduced T_e will now be smaller. It is shown that the low-density approximation for [O III] I(4363.20)/I(5007.57) is valid only for $N_e < 10^4$. A coronal line observed at 1668.5 Å is tentatively assigned to a [P x] transition. (auth)

32930 INTERNAL POTENTIAL OF HETEROGENEOUS ELLIPSOIDS. Levin, M. L.; Muratov, R. Z. (Radiotechnical Inst., Moscow). Astrophys. J.; 166: No. 2, 441-5(1 Jun 1971).

General explicit expressions were found for the potential inside an ellipsoid in which the density varies as integral powers of coordinates. A simple method of passing from an even-power case to an odd-power one is given. (auth)

32931 MASS FUNCTIONS OF CLUSTERS AND THE DISTRIBUTION OF STARS IN THE COLOR–MAGNITUDE DIAGRAM. Schlesinger, Barry M. (Indiana Univ., Bloomington). Astrophys. J.; 166: No. 2, 447-50(1 Jun 1971).

The variation with age of the actual number of cluster stars occupying a given area of the C–M diagram is sensitive to the mass function of the cluster. The relative number of stars in different parts of the H–R diagram for a cluster of a given age is not sensitive to the mass function. Evidence is presented which reinforces a previous result that the giants in the Hyades and clusters of similar age are burning core helium. (auth)

32932 SIX MAIN-SEQUENCE ECLIPSING BINARIES OF TYPES A TO F. Popper, Daniel M. (Univ. of California, Los Angeles). Astrophys. J.; 166: No. 2, 361-72(1 Jun 1971).

Spectroscopic observations and orbital analyses are presented of six eclipsing binaries, each with approximately equal components: DM Vir, CD Tau, BS Dra, HS Hya, and EI Cep of type F, and V451 Oph near A0. The results for CD Tau and BS Dra confirm values of the amplitudes of the velocity variations found earlier by others. In the case of EI Cep there is a moderate improvement, and for V451 Oph a substantial improvement, over older work. The objects DM Vir and HS Hya are recently discovered binaries. The principal results are given in a table. While the available light curve of EI Cep is of good quality, it leaves several important questions unanswered. The other four F-type systems lack photoelectric light curves. The components of EI Cep and DM Vir appear to be evolved, perhaps outside the main-sequence band; the other four systems appear less evolved. The binary EI Cep presents a case of striking differential metallicism between the components. (auth)

32933 SYNTHESIS OF CLOSE-BINARY LIGHT CURVES. II. DOUBLE DISTORTION AND THE SYSTEMS AS ERIDANI, LAMBDA TAURI, AND RS VULPECULAE. Hutchings, J. B.; Hill, Graham (Dominion Astrophysical Observatory, Victoria, B. C.). Astrophys. J.; 166: No. 2, 373-86(1 Jun 1971).

The theoretical derivation of close-binary light curves, which includes the reflection effect and distortion of the secondary star, is extended to include the distortion of the primary star. Physical data, relative radii, effective temperatures, and mass ratios are derived for the eclipsing systems AS Eri, λ Tau, and RS Vul. The first system has a secondary close to its Roche limit, the second shows strong distortion effects in the primary, and the third has a very strong reflection effect; all three illustrate the versatility of the program. (auth)

32934 PROPERTIES OF HADRON MATTER. I. THE EQUATION OF STATE. Lee, Huan (Massachusetts Inst. of Tech., Cambridge); Leung, Y. C.; Wang, C. G. Contract AT(30-1)-2098. Astrophys. J.; 166: No. 2, 387-404(1 Jun 1971).

The thermodynamical properties of hadron matter at high temperatures were investigated within the framework of statistical mechanics and high-energy physics. A brief review of recent developments in high-energy physics is given which leads to the justification of a dynamical model of particle interactions called the dual-resonance model. With this model an ultimate temperature $T_0 = 2 \times 10^{12}$°K is predicted in support of a recent proposal by Hagedorn. The equation of state obtained for hadron matter exhibits a slope on the plot of pressure versus energy density that is small in comparison with, for example, a relativistic gas, which is an indication that the hadron matter at high temperatures is quite "soft." The significance and validity of these results are discussed. Implications for hadron stars and for cosmological problems of the early Universe will be discussed in Papers II and III. (auth)

32935 ENHANCEMENT OF THE 3 ^{4}He → ^{12}C REACTION RATE BY INELASTIC PROTON SCATTERING. David, Cary N.; Bonner, T. I. (Univ. of Texas, Austin). Astrophys. J.; 166: No. 2, 405-10(1 Jun 1971).

The reaction ^{12}C(p, p')^{12}C*(7.65) was studied in the energy range just above threshold. The measured total cross-section was used to calculate the enhancement of the 3 ^{4}He → ^{12}C reaction rate by inelastic proton scattering. A resonance was found in the cross section corresponding to a stellar temperature of about 2×10^{9}°K. The enhancement of the 3 ^{4}He → ^{12}C reaction rate was found to be significant in certain high-density, high-temperature stellar environments. (auth)

32936 ORBITAL ELEMENTS AND DIMENSIONS OF ECLIPSING SYSTEM MM HER. Imbert, M. (Observatorie, Marseille). Astron. Astrophys.; 12: No. 1, 155-60(Apr 1971). (In French).

The orbital elements were determined for the eclipsing binary MM Her (HD 341475, m_{pg} 9.8) from 27 observations. The velocities of the secondary component were deduced only from H and K lines that appear in emission. An IBM 1130 computer was used to improve the elements by the method of least squares. Definitive elements were obtained. The analysis of light curve deduced from visual observations by Cisevič, enables one to determine the photometric elements. The combination of the photometric and spectroscopic elements gave the physical parameters of the system. The spectral type of the principal component appears to be G8 IV. (auth)

32937 FLARE ACTIVITY OF BY DRA (HDE 234677). Cristaldi, S.; Rodono, M. (Univ., Catania, Italy). Astron. Astrophys.: 12: No. 1, 152-4(Apr 1971).

The flare character of BY Dra (Sp K6Ve), suspected by Popper (1953), is proved by means of photoelectric observations carried out at the stellar station of Catania Astrophysical Observatory. (auth)

32938 PHOTOELECTRIC OBSERVATIONS OF THE P CYGNI-TYPE STARS AG CARINAE AND HR CARINAE. Wisse, P. N. J.: Wisse, M. (Republic Observatory, Johannesburg). Astron. Astrophys.: 12: No. 1, 149-51(Apr 1971).

UBV observations of the P Cygni-type stars AG Carinae and HR Carinae are presented. Both stars increased in brightness in the period JD 2440700 to 2440760. For both, the (B – V) remained more or less constant, while small variations might have been present in the (U – B). (auth)

32939 PHOTOELECTRIC OBSERVATIONS OF SOUTHERN LONG PERIOD VARIABLE STARS. Wisse, M.; Wisse, P. N. J. (Republic Observatory, Johannesburg). Astron. Astrophys.: 12: No. 1, 143-8(Apr 1971).

UBV observations of six long-period variables of different types are presented. They are: one Mira star (S Car), two SRb type stars (RR Car, SW Vir), one RV Tauri (?) star (IW Car), and two irregular ones (RW Vir, U Hya). The results are in good agreement with earlier observations by Smak (1964). (auth)

32940 ANALOGY OF SOUND WAVES AND SHALLOW WATER WAVES. Kuperus, M. (Univ. of Utrecht). Astron. Astrophys.: 12: No. 1, 85-7(Apr 1971).

The analogy between the propagation of shallow water waves and sound waves is discussed. It is suggested that laboratory experiments with shallow water in a vessel with varying depth and width can be used to study the propagation of sound waves in a gravita-

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tional atmosphere. It is shown that, in some cases, the depth and the width of the vessel serve as the analogon for the temperature and the density in the atmosphere. (auth)

32941 INTERPRETATION OF PHOTOMETRIC AND MKK SPECTRAL TYPES OF EARLY, MAIN-SEQUENCE STARS. Schmitt, A.; Scholz, M.; Traving, G. (Univ., Heidelberg). Astron. Astrophys.; 12: No. 1, 36-42(Apr 1971).

Effective temperatures of O5 to A0 near-main-sequence stars are derived from model vs. observed Balmer jumps on the one hand, and from model vs. observed strength ratios of MKK classification lines on the other. No obvious systematic discrepancies occur. The line strength ratios, however, are poorly suited to determine mean effective temperatures of early, main-sequence stars. (auth)

32942 EQUILIBRIUM STARS WITH DEGENERATE HELIUM CORES AND HYDROGEN BURNING SHELLS. Giannone, P.; Refsdal, S. (Univ. of Nebraska, Lincoln. Osservatorio Astronomico, Rome. Hamburger Sternwarte, Hambrug). Astron. Astrophys.; 12: No. 1, 28-35(Apr 1971).

Models of equilibrium stars with a degenerate helium core and a hydrogen burning shell were investigated. Sequences of models with increasing core mass were calculated for various total masses and chemical compositions. Such equilibrium models are fairly good approximations to models of real stars on the ascending red-giant branch before the helium flash. (auth)

32943 CONVECTIVE ENVELOPES AND ACOUSTIC NOISE GENERATION IN WHITE DWARFS. Boehm, K. H.; Cassinelli, J. (Univ. of Washington, Seattle). Astron. Astrophys.; 12: No. 1, 21-7(Apr 1971).

Twenty-six convective envelopes for helium-rich white dwarfs with $g = 1.0 \times 10^8$ cm s^{-2} and effective temperatures in the range 5,790 to 30,000°K were computed. Partial electron degeneracy and pressure ionization were taken into account. For a white dwarf of $T_{eff} = 11{,}000$°K, the convection zone reaches a thickness of about 31 km and temperature (at the bottom of the zone) of 2.4×10^6 °K. In cool white dwarfs a relatively high degree of degeneracy is found at the bottom of the convection zone. In white dwarfs with effective temperatures above 20,000°K, degeneracy in the convection zone can be completely neglected. The maximum convective velocity varies from 50 m s^{-1} in the coolest to 6.05 km s^{-1} in the hottest models. The total acoustic flux reaches its largest value (1.5×10^{11} erg cm^{-2} s^{-1}) for $T_{eff} = 3 \times 10^4$ °K. The maximum ratio of acoustic to total flux is 0.7% and occurs in a white dwarf of 22,000°K. The formation of coronae of hot white dwarfs is discussed. (auth)

32944 NARROW-BAND PHOTOMETRY OF EARLY-TYPE STARS. Haeggkvist, L. (Uppsala Astronomical Observatory). Astron. Astrophys.; 12: No. 1, 5-15(Apr 1971).

Photoelectric determinations of the Hγ absorption are presented for 365 northern stars ($\delta > 0°$), including nearly all stars brighter than V = 5.10m classified as A2 or earlier. The observations were performed by using three interference filters with transmission maxima at the wavelengths 4059, 4346, and 4508 Å. The Hγ absorption, γ, a monochromatic magnitude, m_{4508}, and a color equivalent were determined from the observations. Comparison made with hydrogen-line absorptions observed by other authors and the relations between γ and these quantities are presented. The intrinsic color $(B-V)_0$ determined from the observations of the Hγ absorption and absolute magnitudes calculated from mean reduced parallaxes and from proper motions combined with radial velocities are given. These absolute magnitudes are compared with those derived by Sinnerstad, Petrie, Fernie, and Graham. The best agreement was found with the values derived by Sinnerstad. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstract 33086.

32945 DUAL-FREQUENCY ORTHOGONAL STRIP DISTRIBUTIONS OF LINEARLY POLARIZED AND TOTAL RADIATION IN EIGHT EXTRAGALACTIC RADIO SOURCES. Seielstad, G. A.; Weiler, K. W. (California Inst. of Tech., Pasadena). Astron. J.; 76: 211-22(Apr 1971).

One-dimensional distributions of the total and linearly polarized radiation from 3C 227, 3C 270, 3C 278, Cen A (central), 3C 327, Her A, 3C 353, and 3C 403 were obtained at frequencies of 1420 and 2880 MHz. Both right-ascension and declination scans are presented. Distributions of depolarization, rotation measure, and intrinsic polarization angle were calculated. Variations of spectral index within sources are noted. The magnetic field near the center of many radio galaxies is perpendicular to the major axis; in the outer components it is either approximately perpendicular or parallel. Correlations are found between rotation measure and depolarization rate in some cases. (auth)

32946 GALACTIC RADIO EMISSION AT 610.5 MHz. III. THE REGION BETWEEN GALACTIC LONGITUDES 108° AND 138°. Webb, Harold D.; Dickel, John R. (Univ. of Illinois, Urbana). Astron. J.; 76: 223-30(Apr 1971).

A section of the galactic plane between galactic longitudes of 108° and 138° was observed with a resolution of 16 by 20 min of arc at 610.5 MHz. A contour map is presented for this region, and a number of discrete sources are recognized and discussed. (auth)

32947 MODEL FOR COSMIC INFRARED SOURCES. Wickramasinghe, N. C. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London) Phys. Sci.; 230: 166-9(19 Apr 1971).

It is argued that observations relating to intense, compact cosmic sources of infrared radiation may be accounted for by models in which sources of cosmic rays at the nuclei of galaxies are surrounded by dust shells that absorb and re-emit this energy. (auth) (UK)

32948 RAPIDLY ROTATING PULSARS AND JACOBI ELLIPSOIDS. Chau, W. Y.; Srulovicz, P. (Queen's Univ., Kingston, Ont.). Phys. Rev., D; 3: 1999-2000(15 Apr 1971).

In connection with the evolution of a rotating Jacobi ellipsoid through the emission of gravitational radiation, the possibility that rapidly rotating pulsars can assume such triaxial, non-axisymmetrical configurations is discussed. (auth)

32949 STATISTICS OF THE OPTICAL VARIATIONS OF A LARGE SAMPLE OF QUASARS. Folsom, G. H.; Smith, A. G.; Hackney, R. L.; Hackney, K. R. (Univ. of Florida, Gainesville). Nature (London) Phys. Sci.; 230: 199-200(26 Apr 1971).

Data are given from regular monitoring of a large group of extragalactic radio sources since Dec. 1968, carried out with the 30-inch reflector at the University of Florida, Rosemary Hill Observatory, most of the sources being quasars but also including a few Seyfert galaxies and N galaxies, which are regarded as possible evolutionary relatives of the quasars. Identifications, approximate photographic magnitudes, average radio spectral indexes, and type of optical variability are given. Of 26 quasars, 12% showed violent activity, 50% were moderately variable, 12% have shown changes but are not currently active, and 26% have shown no change. A correlation between optical activity and a small radio spectral index was confirmed, and a similar correlation was found for five compact galaxies. In Dec. 1969 the 0.7-m Maksutov telescope of the El Roble Astronomical Station in Chile was used to extend the survey to 80 southern hemisphere radio sources, changes of 0.2 mag. or more were observed in 48% of the 34 quasars, and 9% showed variations of the order of 1 mag. A histogram is presented for 53 quasars for which adequate radio indices were available, showing the relationship between large-amplitude optical variations and radio spectral index; there was a striking correlation between large-amplitude optical fluctuation and a radio spectral index of small absolute size. A characteristic of a number of the most active sources was an alternation between intervals of violent fluctuation and periods of near quiescence, as evidenced by the light curve of PKS 2345-16, and it was evident that firm conclusions can be drawn only from an extended period of close monitoring. (UK)

32950 UPPER LIMIT TO THE FLUX DENSITY FROM SCO X-1 AT 408 MHz. Jauncey, D. L. (Cornell Univ., Ithaca, N. Y.). Nature (London) Phys. Sci.; 230: 200(26 Apr 1971).

An attempt was made in August 1969 to detect this very weak radio source at 408 MHz using the multiple beams of the 1-mile cross of the Molonglo Radio Observatory. A mean upper limit of ~0.06 f.u. was found at this frequency, which is consistent with a synchotron spectrum rather than a thermal bremsstrahlung interpretation. Some estimates of the spectral index are also given. (UK)

32951 SURVEY OF THE SKY AT 610.5 MHz. IV. THE REGION BETWEEN DEC. +27° AND +31.5°. Dickel, J. R.; Webber, J. C.; Yang, K. S. (Univ. of Illinois, Urbana). Astron. J.; 76: 294-304(May 1971).

The fourth section of the catalogue of radio sources being made with the 400-ft radio telescope at the Vermilion River Observatory of the University of Illinois has been completed. The declination range was +27° to +31.5°; small areas were omitted to avoid side-lobe confusion. All sources were tabulated whose 610.5-MHz flux densities were greater than 0.8 f.u. Spectral indices are also given for the sources. A total of 336 sources are listed. (auth)

32952 NEW RADIO RESULTS ON SUPERNOVA REMNANTS. Downes, D. (Harvard Radio Astronomy Station, Fort Davis, Tex.). Astron. J.; 76: 305-16(May 1971).

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A new list of possible supernova remnants, 113 in the Galaxy and four in the Large Magellanic Cloud, has been prepared. Fourteen sources of known distance are found to satisfy a relation between surface brightness Σ and linear diameter d of the form $\Sigma \propto d^{-3.6\pm0.5}$, and this relation is used to derive distances for the remaining sources in the catalogue. The median spectral index of the remnants is −0.5 and there is no correlation between spectral index and surface brightness. The number–brightness relation for the remnants is of the form $N(>\Sigma) \propto \Sigma^{-0.7\pm0.2}$. The Σ–d and N–Σ relations are interpreted in terms of a constant magnetic field strength in the remnants and a deceleration of the shells in accord with the blast-wave solution of Sedov and of Taylor. It is suggested that the magnetic field in shells of the remnants is simply the compressed interstellar magnetic field. (auth)

32953 OBSERVATIONS OF INTERMEDIATE-VELOCITY CLOUDS AND A MODEL FOR THEIR EXISTENCE. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. J.; 76: 317-21(May 1971).

The results of high-resolution observations of several intermediate-velocity clouds of neutral hydrogen are briefly discussed and summarized. A model involving a supernova in its late "snowplow" phase of evolution to account for the presently observed momentum of the intermediate-velocity matter at high positive galactic latitudes is suggested. The correlation in position with a region of lack of zero-velocity matter is explained if the supernova occurred about 10^6 years ago at a distance of 130 pc so that much of the matter in the solar neighborhood has now been accelerated to the observed negative velocities. (auth)

32954 REDSHIFT WITHOUT REASON. Stubbs, Peter. New Sci. Sci. J.; 50: 254-5(29 Apr 1971).

A long-baseline experiment, involving the radio dishes at Goldstone, California, and Haystack, Massachusetts, has produced the startling result that a quasar, if it is as far away as its redshift implies, must be flying apart at ten times the speed of light. Since this is improbable it questions the entire basis of the redshift/distance relationship. (auth) (UK)

32955 MAGNETIC FIELD STRUCTURE AROUND THE CRAB NEBULA PULSAR. Scargle, J. D. (Univ. of California, Santa Cruz). Nature (London) Phys. Sci.; 230: 37-8(8 Mar 1971).

Reference is made to Forman and Visvanathan (Nature, 229:39 (1971)) who reported linear polarization observations in the central regions of the Crab Nebula, and it is stated that their interpretations of the data in terms of magnetic fields must be substantially modified, since the observations relate to an integration along the line of sight over the entire depth of the nebula. These modifications are discussed, and some previously unpublished data on polarization of the wisps are presented. It seems reasonable to assume from continuum photographs of the Crab that the pulsar is physically surrounded by a cavity of low emissivity, and the radiation measured by Forman and Visvanathan probably originated not near the pulsar but in the foreground and background regions of the nebula; for this reason it seems impossible observationally to make any conclusions about the magnetic field structure around the pulsar, and their data can be represented qualitatively by model in which synchrotron radiation arises in the magnetic field produced by a toroidal current loop viewed nearly edge-on at a position angle of 158° and centered at the pulsar. A similar but much larger torus can be involved to explain the polarization of the "bays" on the east and west ends of the nebula. Other conclusions by Forman and Visvanathan concerning the wisps are also discussed. It is stated that the theoretical discussion of these authors is not self-consistent. (UK)

32956 CIRCULAR POLARIZATION OF QUASARS AT 21 cm. Conway, R. G.; Gilbert, J. A.; Raimond, E.; Weiler, K. W. (Univ. of Manchester, Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 1P-4P(1971).

Measurements of circular polarization in 13 radio sources at λ21 cm are presented and compared with similar measurements at λ49 cm. Quasars appear to have polarization if opaque by synchrotron self-absorption, but not if transparent. The degree of polarization does not vary with wavelength in the theoretically expected manner. (auth) (UK)

32957 ABSOLUTE MEASUREMENTS OF INTENSITY OF RADIATION FROM CASSIOPEIA-A, CYGNUS-A, AND TAURUS-A AT WAVELENGTHS 15 TO 30 cm. Vinogradova, L. V.; Dmitrenko, D. A.; Tseitlin, N. M. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 157-9(1971). (In Russian).

Tabulated data are given for the measurements of the radiation intensities of Cassiopea A, Cygnus A, and Taurus A from 15 to 30 cm measured during Sept. 1969 to Feb. 1970. The spectra obtained were correlated with the spectra of measurements from 7.5 to 15 cm and 30 to 60 cm. For Cas A, the spectral index $\alpha = -0.82 \pm 0.05$ from 3 to 60 cm; for Cyg A from 15 to 30 cm, $\alpha \approx 1.05$. Data for Tau A from 13 to 30 cm correlated with measurements from 7.5 to 15 cm and 30 to 60 cm revealed two peculiarities expressed by a stepline drop $\alpha \approx 0$ at 25 to 40 cm and from $\alpha \approx 0$ at the 12 to 14 cm. (R.V.J.)

32958 MULTICHANNEL SPECTROMETER AND OBSERVATIONS OF SPECTRAL VARIATIONS OF PULSARS CP 0950 AND CP 1133. Brezgunov, V. N.; Udal'tsov, V. A. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 9-14(1971). (In Russian).

The spectrometer described is a receiver with wideband input (30 to 115 Mc) and multi-channel narrow band output (40 and 500 kc). The channels are tuned to different frequencies uniformly distributed over the range (2.8 or 32 Mc). The comb of the received frequencies is adjusted in the limits of 70 to 115 Mc. The spectra of the series of pulses over the frequency range of 83 to 111 Mc are given for the pulsars CP 0950 and CP 1133. The pulse spectra are shown to be strongly varied in time. The change from a typical spectrum to an abnormal one and vice versa has a manner of frequent jumps. It is found that the rotation of the polarization plane of the radio emission in the interstellar medium in the direction to CP 0950 at the frequency of 83 Mc with respect to that at the frequency of 111 Mc does not exceed two radians, and for winter and the night ionosphere, 2.5 radians. These rotations cannot be the reason for the spectrum variations observed. Consideration is given to the impossibility of explaining the spectrum variations by the influence of the electron density inhomogeneities in the interstellar medium. These variations are assumed to be associated with the propagation effects in the envelope of pulsars or with the physics of their radiation. (auth)

32959 OPTICAL MONITORING OF RADIO SOURCES. II. THE N-TYPE AND SEYFERT GALAXIES. Cannon, R. D.; Penston, M. V.; Brett, Rosemary A. Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 79-96(1971).

An optical monitoring programme for quasars was extended to include 19 N-type and Seyfert galaxies. A summary of all previous work on such objects is given. Light curves for ten of these objects are presented. I Zw 0051 + 12, II Zw 2130 + 09 are new variables and the suggested variability of NGC 1275 and NGC 7469 is confirmed. The patterns of variability are found to be similar to those found among quasars. Some quasar-like galaxies are optically violently variable (OVV) and among both OVV and non-OVV objects many show "standstills" lasting of the order of one year. The proportion of Seyfert and N-type galaxies that are OVV is higher than for quasars. The correlation between OVV activity and flatness of the radio spectrum or radio variability is maintained for objects that are also radio sources. The light curves of 3C 371 and 3C 390.3 are strangely similar. The brightness of some N galaxies in the past provides a "continuity" argument, showing that some quasars at least are cosmological. (auth) (UK)

32960 INITIAL SEARCH FOR THE INTERSTELLAR FORMYL RADICAL, HCO, AND FOR $HC^{13}O^+$. Jefferts, K. B. (Bell Telephone Labs., Holmdel, N. J. Bell Telephone Labs., Murray Hill, N. J.); Penzias, A. A.; Wilson, R. W.; Kutner, M.; Thaddeus, P. Astrophys. Lett.; 8: 43-4(Mar 1971).

The $0_{00}-1_{01}$ transition of HCO at 86.796 GHz was sought but not found in the direction of five galactic radio sources showing strong lines of CO or H_2CO. A predicted line of $HC^{13}O^+$ at 86.708 GHz was also not detected. (auth)

32961 SYNCHROTRON RADIATION FROM PARTICLES WITH SMALL PITCH ANGLES. Melrose, D. B. (Australian National Univ., Canberra). Astrophys. Lett.; 8: 35-7(Mar 1971).

Limits on the degree of circular polarization of synchrotron radiation (i) for particles with very small pitch angles, and (ii) at very low frequencies are presented. (auth)

32962 COMPTON EFFECT IN VARIABLE RADIO SOURCES. Walmsley, C. M. (Univ. of California, San Diego). Astrophys. Lett.; 8: 27-30(Mar 1971).

Models of the variable radio components of the Seyfert galaxies 3C 84 and 3C 120 are postulated from recent results of long baseline interferometry. The spectrum of promoted Compton photons and the lifetimes of electrons against Compton loss are calculated. It is concluded that it should be possible to observe promoted photons in the optical and x-ray ranges early in a source's lifetime. Injection of electrons in such a source must persist over a considerable fraction of the source's life. (auth)

32963 MULTIPLICITY OF SECONDARY PERIODICITIES IN PULSAR CP 0834. Slee, O. B.; Mulhall, P. S. (CSIRO, Sydney). Astrophys. Lett.; 8: 5-9(Mar 1971).

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Spectra of pulse energy fluctuations for CP 0834 were derived from about 17,000 pulses, using the Culgoora radioheliograph operating at 80 MHz. Two types of spectra were computed: (i) spectra derived from "on-pulse" sampling; (ii) spectra derived from sampling at 32 sec^{-1}. The "on-pulse" spectra confirmed the duplicity of the pronounced secondary periodicity in the pulse energy fluctuations, first reported by Slee and Mulhall (1970). The spectrum from (ii) clarified the aliasing problems present in (i) and showed that the two preferred modulating frequencies were $f_{m1} = 0.4220$ Hz and $f_{m2} = 0.4251$ Hz. The relationship between peaks in the pulse energy fluctuation spectra and the phenomenon of marching subpulses is also discussed. It is shown that the frequency stabilities of the pulse modulations, especially that of CP 0834 (±2% of its mean frequency), make it improbable that they are directly related to the relatively unstable subpulse frequencies. There is no evidence in these spectra for the presence of subpulses in CP 0834, at least up the nominal cutoff frequency of 20 Hz. (auth)

32964 FINE STRUCTURE OF CYGNUS A. Miley, George K.; Wade, C. M. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 8: 11-15(Mar 1971).

Results of interferometric observations of Cygnus A at 2695 MHz with baselines of up to 3×10^5 wavelengths are presented. The two small radio cores were resolved. The data for the westerly core can be explained by a double model with components extended by ~1 arc sec and separated by 4.6 arc sec in a position angle of 130 arc deg. The easterly core also consists of at least two components with sizes ~0.5 to 0.6 arc sec. Some astrophysical implications of this result are discussed. (auth)

32965 OHIO SOURCE COUNTS: COMMENTS BY HARRIS AND KRAUS. Harris, B. J.; Kraus, J. D. (Ohio State Univ., Columbus). Nature (London) Phys. Sci.; 230: 140(5 Apr 1971).

Reference is made to Jauncey and Niell (Nature Phys. Sci., 229: 223(1971)) who pointed out that the flux densities of sources in the Ohio survey tend to be underestimated at low values. The principal cause of this underestimation was traced to an error in data reduction which affected certain sources, and corrections are indicated. It is stated that although the error has some effect on the number-count statistics, it is sufficiently small so as not to affect the conclusions in Nature, 227: 785(1970). The criticisms of Jauncey and Niell are considered to be invalid. (UK)

32966 VARIATIONS IN FREQUENCY AND INTENSITY OF 1.35-CENTIMETER H_2O EMISSION PROFILES IN GALACTIC H II REGIONS. Sullivan III, Woodruff T. (Naval Research Lab., Washington, D. C. Univ. of Maryland, College Park). Astrophys. J.; 166: No. 2, 321-32(1 Jun 1971).

Observations are reported of 1.35-cm $6_{16} \rightarrow 5_{23}$ H_2O emission in the galactic sources W3, Ori A, and W49 over the period 1969 January to 1970 June. Remarkable changes have occurred in the complex frequency structure of the line profiles and in the intensity, width, apparent radial velocity, and polarization of the individual features. Each of the features contributing to an H_2O profile arises from a separate dense region able to sustain maser emission and associated with an H II region. The changes in intensity and width of features are consistent with a partially saturated maser in a medium undergoing changes in pump power and gain of the maser. Hyperfine structure and blending of independently varying features can account for the apparent shifts in velocity. On one possible model a typical maser has a gain ~10^{10}, kinetic temperature ~500°K, dimensions ~$1 \times 1 \times 100$ a.u., and H_2O density ~5×10^3 cm^{-3}. The degree of saturation and physical conditions vary greatly, however, from feature to feature. (auth)

32967 RADIATIVE TRANSFER IN AN IONIZED MEDIUM AT HIGH TEMPERATURE. Loh, E. D.; Garmire, G. P. (California Inst. of Tech., Pasadena). Astrophys. J.; 166: No. 2, 301-9 (1 Jun 1971).

The spectral emission of a spherical plasma cloud at 35 and 50 million degrees is presented for several radii in units of electron-scattering lengths. The x-ray emission is found to be enhanced and the effective radiation temperature increased over the electron temperature. Spectral-line intensities within the Doppler line width are found to be substantially reduced over the optically thin estimates. For clouds of small radius and high density, photoionization plays an important role in determining line intensities. (auth)

32968 IMPLICATIONS OF THE WAVE FIELD THEORY OF THE CONTINUUM FROM THE CRAB NEBULA. Rees, M. J. (Inst. of Theoretical Astronomy, Cambridge, Eng.). Nature (London) Phys. Sci.; 230: 55-7(15 Mar 1971).

Some tests of the hypothesis that the continuum radiation from the Crab Nebula arises from relativistic electrons moving in a low-frequency wave generated by the central pulsar are proposed. (auth) (UK)

32969 PULSAR CP 0328 AT 1,420 MHz. Cole, T. W. (Sterrewacht, Leiden); Weiler, K. W. Nature (London) Phys. Sci.; 230: 114-15(29 Mar 1971).

Some observations made with the Westerbork Synthesis Radio Telescope (WSRT) over a continuous period of 12 h at 1415 MHZ are reported. This long and continuous observation gave information on the pulsar mean intensity, as well as a measure of the longer-term fluctuations in intensity due to interstellar scintillations. A description of the WSRT is included. A mean pulsar intensity of $1.28 \pm 0.05 \times 10^{-27}$ $W/m^2/Hz$ was found, or a mean pulse energy of 0.95×10^{-27} $J/m^2/Hz$. A frequency cut-off near 600 MHz was implied, with a spectral index above this of −2.8. Some unusual features of the pulsar are mentioned. The results presented are a preliminary part of a more complete study of the average properties of pulsars at 1415 MHz. (UK)

32970 CONTINUUM MAP OF M 17 AT λ 1.94 cm AND ITS RESTORED BRIGHTNESS DISTRIBUTION. Gordon, M. A. (National Radio Astronomy Observatory, Green Bank, W. Va.).; Williams, T. B. Astron. Astrophys.; 12: No. 1, 120-5(Apr 1971).

Observations of a region nearly 1° square, made with the 120-ft telescope of Haystack Observatory, show M17 (Omega Nebula) to be highly complex and to extend at least 20 arc min in declination and 40 arc min in right ascension. Peak antenna temperatures are approximately 400 standard deviations above the background noise. The map was restored by the chord technique. Two-dimensional gaussians fitted to the four most intense components apparent on the restored map include 68% of M17's total flux density of 656 ± 40 f.u. (auth)

32971 HIGH-VELOCITY COMPLEX AROUND $l^{II} = 130^0 b^{II} = 45^0$: A SINGLE CLOUD. Encrenaz, P. J. (Observatoire, Meudon, France); Penzias, A. A.; Gott III, R.; Wilson, R. W.; Wrixon, G. T. Astron. Astrophys.; 12: No. 1, 16-20(Apr 1971).

Spectra in the region between the two most intense components of the high velocity complex around $l^{II} = 130^0$ $b^{II} = 45^0$ are presented. The spectra show a smooth bridge of gas between these two clouds with column densities in excess of 3×10^{18} $atoms/cm^2$. (auth)

Solar Phenomena

Refer also to abstracts 32230, 33092, 33116, and 33120.

32972 (LA-4454(Vol.3)) VELA V AND VI SOLAR X-RAY ATLAS, III. JANUARY 1 TO MAY 15, 1970. Blocker, N. K.; Fehlau, P. E.; Kunz, W. E.; Chambers, W. H.; Fuller, J. C.; Milkey, R. W. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 136p. Dep. NTIS.

Data obtained from the solar radiation monitors on the Vela V Satellites are presented. Equivalent graybody flux in three bands (0.3 to 3, 1 to 8, and 1 to 16 Å) is plotted as a function of universal time, one day per page. Data from January 1 to May 15, 1970, are presented. (auth)

32973 (LA-4454(Vol.4)) VELA V AND VI SOLAR X-RAY ATLAS, IV. APRIL 11 TO SEPTEMBER 1, 1970. Blocker, N. K.; Fehlau, P. E.; Kunz, W. E.; Chambers, W. H.; Fuller, J. C.; Milkey, R. W. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 144p. Dep. NTIS.

Data obtained from the solar radiation monitors on the Vela VI Satellites are presented. Equivalent graybody flux in three bands (0.3 to 3, 1 to 8, and 1 to 16 Å) is plotted as a function of universal time, one day per page. Data from April 11 to September 1, 1970, are presented. (auth)

32974 (MIT-3980-61) MAGNETIC ENERGY CONVERSION PROCESSES AND SOLAR FLARES. Coppi, B. (International Centre for Theoretical Physics, Trieste (Italy)); Friedland, A. (American Science and Engineering, Inc., Cambridge, Mass.). Sep 1970. Contracts AT(30-1)-3980; NAS5-9041. 55p. (IC-70/151). Dep. NTIS.

A model for the onset and development of solar flares, relying on the transformation of magnetic energy to kinetic energy in a plasma, is presented. A two-dimensional configuration with plasma counterflows across magnetic fields of opposite polarities is considered. The flow velocities are subsonic and subalfvénic, so that no shock-wave process is considered, but sufficiently large to generate a relatively strong electric field. This sets up a sequence of instabilities, the first of which is explosive, in the region of zero magnetic field. The result is emission of high-energy particles and generation of a strong turbulent electrical

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resistivity. From here on, conversion of magnetic energy into thermal and flow energy occurs as a consequence of a tearing-like mode, assumed to be set up around the same region. (auth)

32975 DEGREE OF ANISOTROPY OF COSMIC-RAY ELECTRONS OF SOLAR ORIGIN. Allum, F. R. (Univ. of Texas, Dallas); Palmeira, R. A. R.; Rao, U. R.; (and others). Solar Phys.: 17: 241-68(Mar 1971).

Data obtained by the Explorer 34 satellite regarding the degree of anisotropy of $\gtrsim$70 keV electrons of solar origin are reported. It is shown that the anisotropies are initially field aligned, and that they decay to $\lesssim$10% in a time of the order of 1 hr. The decays of the concurrent ionic and electronic anisotropies for one well observed event are in good agreement with the diffusive propagation model of Fisk and Axford. The data suggest parallel diffusion coefficients for both ions and electrons that are rigidity independent. From considerations of a long-lived electron event, it is shown that the electronic fluxes exhibit "equilibrium" anisotropies at late times. These are interpreted as indicating that convective removal at the solar-wind velocity is the dominant mechanism whereby solar cosmic-ray electrons ($\simeq$70 keV) leave the solar system. They also indicate that there is a positive density gradient at late times in a solar electron event. The data suggest that this was established prior to the establishment of a similar gradient for the cosmic-ray ions. (auth)

32976 SOFT SOLAR X-RAYS AND SOLAR ACTIVITY. IV. SOME EVIDENCE FOR THE ALTITUDE OF X-RAY SOURCE VOLUMES IN SOLAR FLARES. Teske, Richard G. (Univ. of Michigan, Ann Arbor). Solar Phys.: 17: 181-93(Mar 1971).

Soft x-ray (8 to 12 Å), optical, and radio data were analyzed for times during which flares were inferred to have taken place just behind the Sun's limb (infra-limb flares). The analysis, together with the probable positions of the inferred flares, suggests that the soft x-ray source volume lies below the cm-λ radio source, and that the flare impulse or explosion may in some flares be located at an atmospheric level near 10^4 km altitude. (auth)

32977 COHERENT SYNCHROTRON DECELERATION AND THE EMISSION OF TYPE II AND III SOLAR RADIO BURSTS. Kuckes, A. F.; Sudan, R. N. (Cornell Univ., Ithaca, N. Y.). Solar Phys.: 17: 194-211(Mar 1971).

Coherent synchrotron deceleration of 100-keV electrons is proposed as the mechanism by which type-II and -III solar radio bursts are generated. This mechanism directly excites the transverse electromagnetic radiation by a linear mechanism at the relativistic electron cyclotron frequency and at the first harmonic thereof if the energy spread of the exciting component is sufficiently narrow. Higher cyclotron harmonics are excluded by the energy spread in the 100-keV exciting electron component. This mechanism appears to fit the observational data concerning these emissions somewhat better than the existing theory based on the nonlinear interaction of electrostatic plasma waves. (auth)

32978 X-RAY OBSERVATIONS OF SOLAR ACTIVE REGIONS FROM OSO-5. Parkinson, J. H.; Pounds, K. A. (Univ. of Leicester, Eng.). Solar Phys.: 17: 146-59(Mar 1971).

Observations of solar-active regions by a grazing-incidence x-ray telescope on board OSO-5 are reported. The evolution of the hot, coronal components of active regions was studied during successive rotations across the solar disc. In particular, it was found that the x-ray emission is very dependent on the photospheric magnetic field. Models of active regions were constructed as a function of the underlying magnetic field. (auth)

32979 METHOD OF CALCULATING 0 TO 20 A SOLAR X-RAY FLUX AND ITS SPECTRAL DISTRIBUTION USING 9.1 cm SPECTROHELIOGRAMS. Sengupta, P. R. (Indian Inst. of Tech., Kharagpur). Solar Phys.: 17: 160-73(Mar 1971).

1 to 8, 2 to 12, and 8 to 20 Å nonflare x-ray flux data and 9.1 cm spectroheliograms for 1237 days during the period July 1966 to June 1970 were studied to derive physical models of $\lambda < 20$ Å x-ray emitting regions on the Sun under quiescent (nonflare) conditions. The preferred regions of emission below 20 Å which coincide with the coronal active regions characterized by enhanced 9.1 cm microwave emission were found to have temperature lying between 1.8 and 3×10^6 K, emission measure 10^{49} to 10^{50}, and electron density 10^9 to 10^{10} per cc. The average area of an active region was 10^{20} cm^2. A slow gradient of temperature and electron density was seen to exist around a region of peak activity, both temperature and electron density decreasing outwards. Based on the derived physical model of the emitting regions a new method is presented for calculating x-ray flux and spectral energy distribution in this wavelength region using daily 9.1 cm solar spectroheliograms. The calculated values are in good agreement with the observed values. (auth)

32980 ISODENSITOMETRIC ANALYSIS OF FLARE ON 1966, MARCH 20. Mazzucconi, F. (Astrophysical Observatory, Arcetri, Italy); Righini, A. Solar Phys.: 17: 174-80(Mar 1971).

The behavior of the McMath A.R. No. 8207 is described from the photometric point of view during the remarkable flare of March 20, 1966. The results of the photometry are compared with the radio and Ly-α emission. (auth)

32981 SCATTERING OF RADIOWAVES FROM COSMIC SOURCES IN THE SOLAR CORONA. Baselyan, L. L.; Sinitsyn, V. G. (Inst. of Radiophysics and Electronics, Kharkov). Solar Phys.: 17: 129-45(Mar 1971).

The scattering of radiowaves in the outer solar corona is discussed. Results are given for the decametric-wave observations. In the theoretical analysis both regular refraction and the gradients in the electron density fluctuations are considered. The theory is in satisfactory agreement with the experimental data. From their comparison, the ratio $n = (l_r/l_t)$ is deduced of the correlation scales in the radial (l_r) and transverse directions. This value is not equal to the ratio of the observed distribution dimensions. The frequency dependence of the angular spectrum rms width is not λ^2 at longer wavelengths. At small separations from the Sun, however, the rms angular size cannot serve as the only characteristic of the spectrum, the latter being non-Gaussian. (auth)

32982 OBSERVATIONS AND DISCUSSIONS CONCERNING HIGH POLARIZATION FEATURES IN THE SOLAR CORONA. Koutchmy, Serge (Institut d'Astrophysique, Paris); Schatten, Kenneth H. Solar Phys.: 17: 117-28(Mar 1971).

Photographic observations were obtained of the radial and tangential polarization of the solar corona for the March 7, 1970 solar eclipse. The corona was photographed using a neutral density filter and rotating linear polaroid sectors to allow the polarization structure to be seen from 1 to 6 solar radii. Anomalously high polarizations were found for structures with the E-tangential intensity being predominantly larger than the E-radial intensity. These structures are generally filamentary in nature and radial in direction. One case with a high radial polarization was also found. The photographs were calibrated accurately against the Earth shine from the Moon. Possible source mechanisms are discussed that may explain this new component in the solar corona. Most sources may be ruled out on physical grounds. One possibility appears to be synchrotron radiation from 10-GeV electrons in a 0.4 G field. The existence of these electrons, however, is unlikely in that spacecraft observations at 1 AU do not confirm their presence. (auth)

32983 THEORETICAL INTENSITIES OF FeXIV IN THE SOLAR euv SPECTRUM. Blaha, M. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys.: 17: 99-116(Mar 1971).

Equilibrium population of Fe XIV levels in coronal conditions was calculated including configurations $3s^23p$, $3s3p^2$, $3s^23d$, $3p^3$, $3s3p3d$, $3s^24s$, $3s^24p$, $3s^24d$, and $3s^24f$. Relative populations of selected levels are given. The dependence of relative intensities of the strongest lines on electron density is shown. Certain line ratios can be used for the determination of N_e. For example, at $T = 2 \times 10^6$ K and with a dilution factor 0.4, the intensity ratio of λ211.3 and λ219.0 changes by a factor of 65 if N_e increases from 10^7 to 10^{11}. Cascades from the $3s3p3d$ and $3p^3$ configurations are important in the population of some levels of $3s3p^2$. A possibility of identification of additional lines in the solar spectrum is indicated. (auth)

32984 INFLUENCE OF HELIUM AND HEAVY ELEMENTS ON THE RADIO ABSORPTION COEFFICIENT (RESEARCH NOTE). Chambe, G.; Lantos, P. (Observatoire, Meudon, France). Solar Phys.: 17: 97-8(Mar 1971).

It is shown that the inclusion of He, C, N, O, Ne, Mg, Si, and Fe ions leads to a nonnegligible increase in the free–free absorption coefficient for the chromosphere–corona transition zone and for the corona. (W.D.M.)

32985 SPECTROPOLARIMETRIC ANALYSIS OF THE SOLAR CORONA DURING THE NOVEMBER 12, 1966 TOTAL ECLIPSE. Caccin, B. (Capodimonte Observatory, Naples); Moschi, G.; Rigutti, M.; Falciani, R. Solar Phys.: 17: 89-96(Mar 1971).

Spectropolarimetric observations of the solar corona during the November 12, 1966 total eclipse were analyzed. The trend of the intensity, the polarization degree p, and the polarization angle α of the coronal continuum are given as functions of ρ and compared with those of other authors. The H and K Ca II lines were observed in emission once again and, through a quantitative analysis, are attributed to scattered prominence light instead of to the corona. (auth)

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32986 SOFT SOLAR X-RAYS AND SOLAR ACTIVITY. III. LOOP PROMINENCES WITH SOFT X-RAY EMISSION. Teske, Richard G. (Univ. of Michigan, Ann Arbor). Solar Phys.; 17: 76-88(Mar 1971).

Soft x radiation between 8 and 12 Å was found to be emitted from the Sun at the time of four optically identified major systems of loop prominences. The peak emission rates and time-integrated x-ray energies were very similar for three of the events, while the fourth appeared to emit x rays only weakly. The data were not consistent with a compression–condensation model for the loops, and supported the fast-proton injection model. Proton injection may take place on a long time scale. (auth)

32987 SPECTRAL ANALYSIS OF FOUR QUIESCENT PROMINENCES OBSERVED AT THE PERUVIAN ECLIPSE. Hirayama, Tadashi (Univ. of Hawaii, Honolulu). Solar Phys.; 17: 50-75(Mar 1971).

Two-dimensional distributions of kinetic temperature, density, and turbulent velocity were obtained for four quiescent prominences observed at the Peruvian eclipse of November 12, 1966. (a) The kinetic temperature derived from line widths was around 6000 to 7000K in the central part of prominences and rises to 12000K in both edges and possibly in the top of prominences. (b) The turbulent velocity shows a similar tendency, being 7 to 9 km/sec in the central part and ≈20 km/sec in the outer part. The turbulent velocity also increases slowly towards higher heights in the prominence. (c) The electron density derived both from the Stark effect and the intensity ratio of the continuous spectra turns out to be about $10^{10.2}$ to $10^{10.6}$ cm^{-3} in the central portion of two prominences. (d) From the width and the intensity, neutral helium lines are shown to originate in the same region as hydrogen and metallic lines where the kinetic temperature goes down to 6000K. This indicates that neutral helium is emitted after the ionization due to uv radiation from the corona and the transition region. (auth)

32988 ORIGIN OF QUIESCENT PROMINENCES. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Solar Phys.; 17: 44-9(Mar 1971).

For stable equilibrium, prominences must be supported with magnetic lines of force leaning upon the photosphere and concave in their tops; however the general structure may be more complicated. If such a field appears in the corona, the heating of the gas near the upper pit should be low, because Alfvén and slow waves do not propagate across magnetic lines and fast mode waves attenuate because of refraction. The gas of the corona, distributed along the magnetic lines tube, cannot keep balance, it should flow down in the pit, condense there and fall down into the chromosphere which is situated at the other end of the magnetic lines and flows through the corona under the effect of a siphon-type mechanism. A similar mechanism for chromospheric structures was earlier suggested by Meyer and Schmidt. A stationary stream along the tube was calculated with allowance for the heat conductivity and radiative cooling of the corona gas. The stream is subsonic and is about 10^{15} cm^{-2} sec^{-1} which corresponds to the prominence formation time of the order of a day. (auth)

32989 EQUIVALENT WIDTHS IN A PENUMBRAL SPECTRUM (A TEST OF THE MOE–MALTBY MODEL). Schleicher, H.; Schroeter, E. H. (Univ., Goettingen, Ger.). Solar Phys.; 17: 31-43(Mar 1971).

From new observational material a curve of growth analysis was made of the penumbra of a large, stable sunspot. The analysis was done relative to the undisturbed photosphere. The results of the analysis were in satisfactory agreement with the penumbral model as published by Kjeldseth Moe and Maltby (1969). Additionally this model was tested by computing the equivalent widths of 28 well selected lines and comparing them with the observations. (auth)

32990 MAGNETICALLY NONSPLIT LINES IN PENUMBRAE. Stellmacher, G. (Institut d'Astrophysique, Paris); Wiehr, E. Solar Phys.; 17: 21-30(Mar 1971).

Line asymmetries of five magnetically insensitive lines in penumbrae were investigated in detail. It is shown that the high Evershed velocities as derived from line satellites originate in dark penumbral regions (DR), the main line components showing small velocities originate in bright penumbral regions (BR). From the depressions of the main line component and the satellite, the intensity of the DR was estimated to be 3.5 times higher than that of umbrae. The area of the BR exceeded that of the DR by a factor of about 1.8. An interpretation of the discrepancy between velocity- and magnetic neutral lines is given. (auth)

32991 SOME PROPERTIES OF VELOCITY FIELDS IN THE SOLAR PHOTOSPHERE. III. OSCILLATORY AND SUPERGRANULAR MOTIONS AS A FUNCTION OF HEIGHT. Deubner, Franz-Ludwig (Fraunhofer Institut, Freiburg i. B.). Solar Phys.; 17: 6-20(Mar 1971).

Photoelectric measurements of Doppler shifts of various Fraunhofer lines obtained with the Capri magnetograph were analyzed. The height dependence of the supergranular and oscillatory motions, as well as the two dimensional structure of these velocity fields were investigated. The most interesting results were the following: (1) oscillatory and supergranular motions are still clearly present in very deep photospheric layers as detected e.g., by means of the C I line at 5380.3 Å; (2) whereas the vertical motions (both of oscillation and supergranulation) increase with height, the horizontal component of the supergranular flow is found to be decreasing slightly; (3) aperiodic horizontal motions are observed in the photospheric layers, which are probably connected with the process of excitation of the oscillatory field; (4) there is no simple way of describing the oscillatory field in terms of independently oscillating "cells", since the two-dimensional pattern changes its appearance drastically already in a fraction of one oscillation period; and (5) the correlation obtained by previous observers between vertical stationary motions, the chromospheric network, and magnetic fields in particular is confirmed. (auth)

32992 THEORY OF SPICULES AND CHROMOSPHERIC STRUCTURE. Pikel'ner, S. B. (Sternberg Astronomical Inst., Moscow). Comments Astrophys. Space Phys.; 3: 33-9 (Mar-Apr 1971).

An attempt is made to explain theoretically the high density of spicules, their large heights, and their upward motions, as well as the energy sources that keep them radiating. (W.D.M.)

32993 LONGITUDINAL DISTRIBUTION OF PCA SOURCES ON THE SUN. Fritzova-Svestkova, L.; Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Solar Phys.; 17: 212-17(Mar 1971).

For 181 PCA's recorded during the years 1956–1969 the association with flares is studied. Both the number of events which cannot be associated with any flare on the visible hemisphere, as well as the longitude distribution of identified proton flares, lead to the conclusion that 25 to 30% of PCA's are caused by flares behind the western solar limb. PCA's of this kind are mostly small. During the investigated years no PCA > 13 dB and possibly no PCA > 8.5 dB were caused by flares behind the limb, while hardly 60% of PCA's < 1 dB had their origin on the visible hemisphere. While the sources of GLE's and of PCA's, in general, are centered around 50°W, which corresponds to the average curvature of the magnetic field lines in interplanetary space, the strongest PCA's (>8.5 dB) show an anomalous longitude distribution centered around ~20°W. It is suggested that this anomaly may be a consequence of the fact that, in strong PCA events, the kinetic energy density of protons below 100 MeV becomes comparable to the magnetic energy density in space, thus leading to a "straightening" of the magnetic field lines. (auth)

32994 LIFETIMES OF EXCITED STATES IN Fe I MEASURED BY THE BEAM-FOIL TECHNIQUE. Andersen, T.; Soerensen, G. (Univ. of Aarhus, Denmark). Astrophys. Lett.; 8: 39-40(Mar 1971).

Radiative mean lives of 29 energy levels in neutral iron were determined by the beam-foil technique and compared with the widely used data of Corliss and co-workers. The present lifetime data deviate from Corliss's results by a factor depending on the level energy, and varying from 1.4 to 35,000 cm^{-1} to 18.5 at 57,000 cm^{-1}. (auth)

32995 ABSOLUTE FLUXES OF PARTICLES ACCELERATED ON THE SUN FEBRUARY 23, 1956. Miroshnichenko, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 708-10(1970).

Translated from Geomagn. Aeron.; 10: 898-9(1970).

The results of the determination of the absolute spectra of particles with a rigidity R ≳ 1 GV are given from ground-based observations of the Feb. 23, 1956 flare. The absolute solar-particle fluxes near the orbit of the Earth (beyond the atmosphere and magnetosphere) and at the source (solar atmosphere) are clarified for the determination. (J.C.W.)

32996 EFFECT OF THE TOTAL SOLAR ECLIPSE OF SEPTEMBER 22, 1968, ON THE GEOMAGNETIC FIELD. Ivanov, N. A.; Borisova, Z. I.; Vishnev, V. S.; (and others) (Inst. of Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 739-40(1970).

Translated from Geomagn. Aeron.; 10: 931-3(1970).

A 100-km wide zone of the total solar eclipse of Sept. 22, 1968 passed from Novaya Zemlya through the Polar and Central Ural, and Central and Southern Kazakhstan. Special observations were

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made to determine the possible influence of this total eclipse on the geomagnetic field. Changes were also observed in other magnetic components which corresponded with the time of the total phase of the eclipse. Electric-field disturbances were also observed. The greatest change in the magnetic field with the total phase of the eclipse occurred at 100 km. Associated changes in the D and E layers are discussed. (J.C.W.)

32997 WHOLE-BODY RESPONSE OF THE MOON TO ELECTROMAGNETIC INDUCTION BY THE SOLAR WIND. Sonett, C. P.; Dyal, P.; Parkin, D. S.; (and others) (Ames Research Center, Moffett Field, Calif.). Science; 172: 256-8(16 Apr 1971).

A comparison has been made of the interplanetary magnetic field as measured both by Apollo 12 on the lunar surface and by Explorer 35 in orbit around the Moon. Two examples are given, one of a step change in the field vector and another of a sinusoidally varying field. A large response measured on the surface is attributed to confinement of the induced field lines between the streaming solar plasma and the high-conductivity interior. A steep bulk electrical conductivity gradient in the lunar crust is implied, with a confining layer roughly 100 km deep. (auth)

32998 TEMPERATURE OF THE SUN IN EARLY HISTORY OF THE SOLAR SYSTEM. Kuroda, P. K. (Univ. of Arkansas, Fayetteville). Nature (London) Phys. Sci.; 230: 40-2(8 Mar 1971).

An attempt was made to determine the temperature of the Sun, shortly after its formation, from the difference in isotopic composition of terrestrial and extraterrestrial Xe, using Xe isotope ratios for typical carbonaceous chondrites, lunar soils, and the Earth's atmosphere. If it is accepted that (a) the enrichment of ^{130}Xe and ^{132}Xe in solar Xe can be brought about only through neutron-capture processes in the Sun, and (b) the ratio of the excess ^{130}Xe (^{130n}Xe) and the excess ^{132}Xe(^{132n}Xe) in the lunar soil is very nearly 1, which is not the ratio expected from capture at room temperatures, it is possible that the $^{132n}Xe/^{130n}Xe$ ratio of the excess at these mass numbers provides information about the ratio of the cross-section values for neutron capture at much higher temperatures, and that this ratio might be used as a "thermometer" for measurement of the temperature of the environment where the capture reactions occurred. Application to determining the temperature of the Sun's interior is discussed. Calculation gives about 8×10^6 K, a value not far from the theoretical reaction temperature for the $^2D(d,n)^3He$ reaction, and possibly near that of the core of the Sun shortly after its birth. (UK)

32999 TIME PERSISTENCE OF ZONES FAVORING THE APPEARANCE OF LARGE GROUPS OF SUNSPOTS. Trellis, Michel (Paris Univ., Nice). Compt. Rend., Ser. B; 272: 549-52(1 Mar 1971). (In French).

In the time scale of the solar cycle, large groups of sunspots occur in privileged longitude intervals. These zones are found at the same heliographic longitudes during many consecutive cycles. (auth) (France)

33000 NEUTRONS AS AN ENERGY SOURCE FOR THE SOLAR CORONA. Fowler, R. G.; Haskemi, J. (Univ. of Oklahoma, Norman). Nature (London); 230: 518-20(23 Apr 1971).

Reasons are given as to why the exothermic decay of a neutral particle, such as the neutron, is an attractive possibility as an energy source for the solar corona. On the average the decay electrons carry 0.39 MeV, which is lost after collisions with the coronal gas, so heating the corona, and the decay protons are formed with a temperature of 2×10^6 K; the neutron process thus has an energy scale comparable with that of the corona. Decaying experimentally in time over their path outward from the Sun, most of the neutrons would decay at the base of the corona, which explains the sudden rise of temperature from the chromosphere to the corona. It is concluded that, altogether, the neutron is an ideal entity as a transfer agent for the coronal energy. The mechanism of neutron release in the photosphere presents some difficulty. Two possibilities are subsurface thermonuclear reactions and production of flares, of which the latter seems more probable. In analyzing the neutron model of the corona it was found that neutrons alone cannot account for the solar wind, or the corona would be vastly hotter than it is; a mixed flux of neutrons, protons, and electrons must originate at the base of the corona, and the required neutron flux is estimated. Qualitatively, the neutron hypothesis is attractive; it is independent of the internal solar source of the neutrons. Inability to discover any suitable source, however, would be the eventual undoing of the hypothesis. Considerable attention is given to this problem, with few positive results, however. Mechanisms examined include a subsurface thermonuclear process such as the D–D reaction, and a surface electrical process. (UK)

33001 ENHANCED EMISSION OF IRON NUCLEI IN SOLAR FLARES. Price, P. B.; Hutcheon, I.; Cowsik, R.; Barber, D. J. (Univ. of California, Berkeley). Phys. Rev. Lett.; 26: 916-19 (12 Apr 1971).

Etched tracks in an Apollo-12 spacecraft window and a Surveyor-3 camera-lens filter give the interplanetary Fe energy spectra from ~1 to ~30 MeV/nucleon during 1967–1969. The strongly energy-dependent Fe/He ratio suggests that heavy nuclei are preferentially emitted from accelerating regions because of their low ionization state and high magnetic rigidity. The Fe fluxes give rise to extremely high track densities observed in lunar soil. (auth)

33002 DECELERATION AND ACCELERATION OF COSMIC RAYS IN THE SOLAR WIND. Jokipii, J. R. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 26: 666-9(15 Mar 1971).

Recent observations of the deceleration of low-energy solar cosmic rays in the solar wind are discussed in the context of cosmic-ray transport theory. It is concluded that the rate of deceleration is much slower than would be produced by adiabatic energy change due to the observed expansion of the plasma, so that a competing acceleration process must be operative. Second-order Fermi acceleration by hydromagnetic waves, acting together with adiabatic energy change, is shown to provide a natural interpretation of the observations. (auth)

33003 SOLAR SUPRATHERMAL EVENT DEDUCED FROM X-RAY LINES. Blake, Richard L.; House, Lewis L. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 166: No. 2, 423-33(1 Jun 1971).

Improved identifications are given for the ionization stages of iron that contributed to the 1.91 Å emission feature in solar spectra obtained by the NRL group in a 1966 rocket flight. In addition, it is shown that the observed emission requires a two-component model of the coronal condensation in which, over some 100 seconds, one component must have either departures from Maxwellian velocity distributions or differences in ionization and electron temperatures. (auth)

33004 EIGENVALUES OF KRAUSE–STEENBECK'S SOLAR DYNAMO. Deinzer, W.; Stix, M. (Univ., Goettingen, Ger.). Astron. Astrophys.; 12: No. 1, 111-19(Apr 1971).

The complex eigenvalues of the Krause–Steenbeck dynamo are evaluated making simplified assumptions about the basic effects. The differential rotation of the Sun, producing toroidal components in an originally meridional magnetic field, is approximated by a step function, with the discontinuity at 0.7 R; the "α-effect," producing meridional components in an originally toroidal magnetic field, is approximated by a δ-function at 0.85 R. For a vanishing α-effect only real eigenvalues are obtained—corresponding to modes decaying exponentially with time. As the α-effect increases some of the eigenvalues are shifted into the complex region—corresponding to oscillatory modes. If their amplitudes are increasing exponentially with time, the dynamo is "excited." Applying the results to the Sun, the only excited mode has an oscillation period of ~2 years. Nonlinear effects, necessary to limit the exponentially increasing amplitudes, are discussed briefly. (auth)

33005 DOPPLER CORE OF THE SOLAR SODIUM D LINES. Worrall, G. (Observatories, Cambridge, Eng.). Astron. Astrophys.; 12: No. 1, 88-97(Apr 1971).

An analytic technique is presented that allows limb-darkening data for strong lines to be analyzed without assuming that the source function is frequency-independent. Application of the method of Waddell's (1962 b) data for the sodium D lines gives a Doppler width of 0.035 ± 0.002 Å and an empirical line source function that is frequency-dependent with a maximum at the line center. This effect is probably caused by a non-Maxwellian velocity distribution for excited sodium atoms. (auth)

Galaxies

33006 STABILITY OF ENCOUNTERLESS SPHERICAL STELLAR SYSTEMS. Doremus, J.-Pierre; Feix, Marc R.; Baumann, Germain (Univ., Nancy). Phys. Rev. Lett.; 26: 725-8(22 Mar 1971).

It is shown that a sufficient condition for stability for the spherical modes of a stellar system is that the distribution function $F(\epsilon)$ decreases with the energy ϵ. For this demonstration the function $F(\epsilon)$ is approximated by a succession of steps corresponding to a multiple "water-bag" model. The total energy is shown to be an absolute minimum: The second variation δW of the energy is always strictly positive and there is no marginal mode. (auth)

33007 VARIABILITY IN THE X-RAY FLUX FROM M87. Janes, A. F. (Univ. of Leicester, Eng.); Pounds, K. A.; Ricketts,

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M. J.; Rees, M. J. Nature (London) Phys. Sci.; 230: 188-91 (26 Apr 1971).

Evidence has been presented recently for variability in both the intensity and spectrum of x rays from the massive elliptical galaxy M87. A new spectral measurement obtained in a rocket flight on November 20, 1970, is reported, and the evidence for variability over the period 1965–70 is re-examined. (auth) (UK)

33008 MASSES OF COMPACT GALAXIES. Chincarini, Guido (Manned Spacecraft Center, Houston, Tex. Wesleyan Univ., Middletown, Conn.). Publ. Astron. Soc. Pac.; 83: 202-4(Apr 1971).

Published observations on compact galaxies indicate that their mass distribution is similar to that for normal galaxies. The average mass-to-luminosity ratio is $(M/L) \simeq 50\ M_\odot/L_\odot$. (auth)

33009 LARGE-SCALE DISTRIBUTION OF GALAXIES AND CLUSTERS OF GALAXIES. De Vaucouleurs, G. (Univ. of Texas, Austin). Publ. Astron. Soc. Pac.; 83: 113-43(Apr 1971).

The nonrandom clustering of galaxies and clusters of galaxies has attracted increasing attention in the past 40 years. The mathematical tests and criteria used to distinguish between an observed distribution and a Poisson, i.e., random, statistically uniform distribution, are outlined. The observational evidence for (and against) hierarchical clustering of galaxies and clusters on various characteristic length scales Λ from 0.1 Mpc to at least 100 Mpc, is reviewed. Some cosmological implications and possible origins of the clustering spectrum are discussed. (auth)

33010 RADIAL VELOCITIES OF H II REGIONS IN M33 AND M101 FROM INTERFERENCE FILTER SCANS. de Vaucouleurs, G. ; de Vaucouleurs, A. (Univ. of Texas, Fort Davis). Astrophys. Lett.; 8: 17-20(Mar 1971).

Radial velocities of outlying emission nebulosities in M33 (23 objects) and in M101 (14 objects) measured with an interference filter scanner are presented to supplement 21-cm data. (auth)

33011 EXPLOSIVE NUCLEOSYNTHESIS IN THE GALAXY. Delano, Michael D. (Yeshiva Univ., New York). Nature (London) Phys. Sci.; 230: 53-4(15 Mar 1971).

The hypothesis that most of the naturally occurring nuclei in the mass range $20 \leq A \leq 62$ were produced by nuclear detonation in supernova explosions is examined in the context of different galactic histories. (auth) (UK)

33012 NEUTRAL-HYDROGEN DISTRIBUTION AND ROTATION PARAMETERS OF THE SPIRAL GALAXY NGC 2403. Burns, W. Robert; Roberts, Morton S. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 166: No. 2, 265-74(1 Jun 1971).

Observations with the 300-foot telescope of the 21-cm hydrogen line of NGC 2403 yield an H I mass of $4.6 \times 10^9\ M_\odot$ and a total mass of $1 \times 10^{11}\ M_\odot$. The integrated H I contour map indicates at least one and possibly two concentrations of hydrogen in the outer regions of this galaxy. A new approach to model fitting of observed velocity profiles is described. Through the use of precomputed and stored coefficients the number of models generated in a given amount of computer time is increased by a factor of about 20. The observed data are well reproduced by both centrally and noncentrally concentrated hydrogen-distribution models, with the latter giving a marginally better fit for a maximum H I column density of 5′ radius. (auth)

33013 DYNAMICS OF FLAT GALAXIES. I. Kalnajs, Agris J. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 166: No. 2, 275-93(1 Jun 1971).

The linearized Vlasov equation that governs the oscillations of a flat collisionless stellar disk is integrated in action-angle variables, and the Poisson equation is solved exactly by use of a logarithmic-spiral representation for the surface densities and potentials. An integral equation for the potential of unstable modes is derived, as well as small-amplitude conservation theorems for angular momentum and energy. A necessary and sufficient condition for the stability of axisymmetric disturbances is derived. (auth)

33014 GENERATION OF MAGNETIC FIELDS IN ASTROPHYSICAL BODIES. VI. PERIODIC MODES OF THE GALACTIC FIELD. Parker, E. N. (Univ. of Chicago). Astrophys. J.; 166: No. 2, 295-300(1 Jun 1971).

It is shown from the dynamo equations that the cyclonic turbulence and nonuniform rotation of the gaseous disk of the Galaxy generate magnetic field in both periodic and nonperiodic modes. Order-of-magnitude estimates of the dynamo number suggest that the large-scale galactic field is generated in the lowest even periodic and/or nonperiodic modes. The characteristic period of the periodic mode is estimated at 10^8 years. The large amplitude of the small-scale (10^2 pc) fluctuations in the internal field of the Galaxy make it difficult to compare the local field observations with theory to designate the mode of the large-scale field extending throughout the disk. (auth)

33015 ORIGIN OF THE NONTHERMAL RADIO EMISSION AT 0.4 TO 6.5 MHz. Lerche, I. (Univ. of Chicago). Astrophys. J.; 166: No. 2, 311-19(1 Jun 1971).

Two explanations of the observed high-intensity, low-frequency nonthermal radio emission have been suggested in the literature. The first, which postdated the observations, is synchrotron radiation from cosmic-ray electrons in the Galaxy; the second, which predated the observations, is enhanced bremsstrahlung at 1 and 2 times the plasma frequency of a discrete source. Both mechanisms were examined in some detail and it was found that it is unlikely that synchrotron radiation by cosmic-ray electrons causes the low-frequency emission in 0.4 to 3 MHz because the interstellar plasma gives a Razin absorption edge which, for numbers currently acceptable for the interstellar medium, is about 0.8 MHz —well above 0.4 MHz where, in fact, radiation is observed. On the other hand, the predicted level, and spectrum, of enhanced bremsstrahlung from a discrete nonthermal radio source agree well with the observed radiation. This predicted radiation gives a consistent picture of the low-frequency emission in the band 0.4 to ~5 MHz. Above 5 MHz the broad-band synchrotron emission from cosmic-ray electrons appears to dominate the narrow-band, discrete-source, bremsstrahlung radiation. (auth)

33016 COMPARISON OF THE INTERSTELLAR 21-CENTIMETER AND SODIUM D-LINES. Hobbs, L. M. (Univ. of Chicago). Astrophys. J.; 166: No. 2, 333-42(1 Jun 1971).

The 21-cm emission lines measured in the directions of thirty stars at intermediate and high galactic latitudes are compared, at a velocity resolution of 0.5 km sec^{-1}, with the interferometrically measured interstellar sodium D-lines for these stars. The agreement between the individual radio and optical components is generally very good. In the majority of cases the ratio of the two column densities, $Q = N(Na\ I)/N(H\ I)$, varies relatively little about an average value of 4×10^{-9} from one region to another. Substantial background contributions to the 21-cm emission from the directions of the brighter Orion stars are found, and the question of the possible depletion of sodium onto dust grains is considered. (auth)

33017 HYDROGEN RECOMBINATION BY NONACTIVATED CHEMISORPTION ON METALLIC GRAINS. Brecher, A.; Arrhenius, G. (Univ. of California, San Diego). Nature (London) Phys. Sci.; 230: 107-9(29 Mar 1971).

The abundance of molecular hydrogen in apparent association with dense, dust-rich interstellar clouds has revived interest in theoretical aspects of H recombination on grains. The possibility of hydrogen recombination and molecule formation by nonactivated chemisorption on surfaces of iron grains is considered. The process seems to be highly efficient over a wide range of grain temperatures, thus complementing the previously proposed recombination by physical adsorption, at low grain temperatures. (auth) (UK)

33018 EXTINCTION BY ROUGH PARTICLES AND THE USE OF MIE THEORY. Greenberg, J. M.; Wavy, R. T. (State Univ. of New York, Albany). Nature (London) Phys. Sci.; 230: 110-12 (29 Mar 1971).

It is shown that the use of Mie theory, or other smooth-particle results, to compute extinction or scattering of small particles in space, for which there is no direct evidence of surface characteristics, may lead to inaccuracy. Some microwave experimental studies on individual particles with precisely defined optical properties and shapes are described, which give a clear indication of the uncertainties in unqualified applications of Mie-type theories. A wide range of size-to-wavelength ratios was used, and special particle-orientation effects are summarised by examining a variety of particle aspects. Results are tabulated for extinction efficiencies of rough spheres, and a stacked cylinder model representing a roughened sphere is shown, together with experimental extinction efficiencies. The 30-m microwaves were emitted from a paraboloidal antenna and the scattered wave detected at a paraboloidal receiver. The instrument employed was calibrated by making equivalent measurements on spheres of given size and refractive index for which Mie theory computations were available. No simple theory appeared able to explain all the results. The findings could be important for Mie-theory predictions of V/V extinction by interstellar particles, composed of ices, graphite, or silicates. (UK)

33019 INFRARED OBSERVATIONS ON THE SIZE OF NGC 1068. Neugebauer, G. (California Inst. of Tech., Pasadena.

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Carnegie Inst. of Washington, D. C.); Garmire, G.; Rieke, G. H.; Low, F. J. Astrophys. J.; 166: No. 2, L45-7(1 Jun 1971).

Infrared measurement of NGC 1068 is presented, showing that at 1.6 and 2.2 μ the source is extended, whereas at 10 μ no significant aperture dependence is observed. (auth)

33020 PRESENCE OF TWO Fe^{3+} BEARING MINERALS IN INTERSTELLAR DUST. Manning, P. G. (Dept. of Energy, Mines, and Resources, Ottawa). Nature (London) Phys. Sci.; 230: 131(5 Apr 1971).

Reference is made to the band spectra of Type I and IV supernovae and it is suggested that there is evidence of Fe^{3+} ions in two different octahedral sites. Particular reference is made to the spectra of SN−NGC 3003. It appears that Fe^{3+} ions can account for most absorption bands in the spectra of supernovae. It is not as yet possible to identify the two Fe^{3+}-bearing minerals with any cetainty, but garnets are not excluded. The study of the spectra of terrestrial oxides and silicates at cryogenic temperatures may lead to reliable identifications. (UK)

33021 NUMERICAL STUDY OF A SIMPLE DYNAMICAL SYSTEM. I. THE ASSOCIATED PLANE AREA-PRESERVING MAPPING. Brahic, A. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 12: No. 1, 98-110(Apr 1971).

Using the method of the "surface of section," the study of a simple dynamical system—a particle confined between two parallel plates, one of which oscillates according to a defined law—is reduced to the study of a plane area-preserving mapping. A systematic numerical exploration of this mapping reveals three qualitatively different regions: for low velocities, the particle has an ergodic behavior; for intermediate velocities, "islands" and ergodic zone coexist; for high velocities, invariant curves across the plane prevent an infinite acceleration of the particle. These results are compared to those of Ulam and those of Zaslavskij and Chirikov, obtained by other methods. In connection with the theorems of Moser and Arnol'd, invariant curves are particularly studied. The system studied, although very simple, exhibits all the typical features found in either one or two dimensional dynamical systems. (auth)

33022 NATURE OF THE FAR ULTRAVIOLET EXCESS IN THE NUCLEUS OF M31. Hills, J. G. (Univ. of Michigan, Ann Arbor). Astron. Astrophys.; 12: No. 1, 1-4(Apr 1971).

The spectral distribution of the far-ultraviolet radiation found by OAO-2 (Code, 1969) in M31 is inconsistent with that emitted by any plausible ensemble of relativistic electrons. However, the spectrum is very nearly a Rayleigh−Jeans distribution which implies that the radiation is produced by an ensemble of thermal sources with mean temperatures in excess of 10^5 °K. The flux density of the ultraviolet excess is consistent with that expected from hot, highly evolved stars, but one cannot rule out the possibility of some of the thermal radiation resulting from activity in the nucleus of the galaxy. (auth)

33023 STRUCTURE OF INTERSTELLAR MATTER. I. KINEMATICS OF THE INTERSTELLAR GAS AND THE BRIGHTNESS TEMPERATURE OF THE 21-cm LINE EMISSION. Rohlfs, Kristen (Mas-Planck-Institut fuer Radioastronomie, Bonn). Astron. Astrophys.: 12: No. 1, 43-58(Apr 1971).

The galactic longitude dependence of the peak brightness temperature of the 21-cm line emission near the galactic equator was investigated with the help of published surveys. Local gas with radial velocities $|V_R| < 30$ km/sec showed a periodic variation of the maximum brightness temperature with $\sin^2 2l$. Two models for the interstellar gas are presented that can account for this behavior the first of which, a one-component model with uniform spin temperature for the gas, has, however, severe shortcomings concerning the explanation of 21-cm absorption observations. The second model, a two-component model consisting of dense cold clouds surrounded by a tenuous hot intercloud medium, does not have these defects. Both the mean temperature and the mean diameter of the clouds are somewhat greater than the models developed by other authors. But these results are not necessarily incompatible since the results here are based mainly on emission data, and the other models rely mainly on absorption measurements. (auth)

33024 SURVEY OF NEUTRAL HYDROGEN IN LOW GALACTIC LATITUDES BETWEEN l = 356° AND 24°. III. NEUTRAL HYDROGEN FAR FROM THE GALACTIC PLANE IN THE INNER REGION OF THE GALAXY. Simonson III, S. Christian (Leiden Observatory. Univ. of Maryland, College Park). Astron. Astrophys.; 12: No. 1, 136-42(Apr 1971).

Nine neutral hydrogen concentrations with high positive velocities that indicate they belong to the inner region of the Galaxy were found between l = 10° and 24°, b = −8° to +5°. Their properties include masses of the order of 10^5 to 10^6 $M_\odot$, velocity dispersions of 7 to 11 km s^{-1}, kinematical distances from the galactic center of 3.5 to 4.7 kpc, and distances from the galactic plane of 200 to 1300 pc. Several appear to be connected to the "expanding arm at +135 km s^{-1}" or to the "Scutum spiral arm." (auth)

33025 BERKELEY SURVEY OF HIGH-VELOCITY INTERSTELLAR NEUTRAL HYDROGEN: DISCUSSION OF RESULTS. Dieter, N. H. (Univ. of California, Berkeley). Astron. Astrophys.; 12: No. 1, 59-75(Apr 1971).

The Berkeley survey of high-velocity neutral hydrogen covers most of the sky observable from northern California, with particular emphasis on the region within ±15° of the galactic plane. The principal observational results of this survey are: (1) The high-velocity gas has as its main component a stratum of material that is extensive both in velocity and in distribution on the sky. Superposed on this background continuum of gas are regions of higher intensity of radiation, often called clouds. These concentrations in intensity are not, however, confined in velocity as they are in angle but show intimate connection with lower velocity material. (2) The velocity of the gas is preponderately negative in sign. (3) The maximum observed radial velocity depends on longitude, but not in a way that is entirely explainable on the basis of differential galactic rotation. (4) The column density of high-velocity gas depends on position but also not in a simple way. The model derived to fit these observations consists of a shell of high-velocity gas that outlines the outermost spiral arms of the Galaxy and that extends to distances of ±3.5 kpc from the plane. This gas has the rotational velocity appropriate to its distance from the galactic center and in addition has a component of velocity directed toward the center with a magnitude of 125 km/sec. The observed average column density within the shell is 4×10^{19} atoms/cm^2; the total mass, 2×10^8 solar masses; and the density (on the assumption of a thickness for the shell of 0.5 kpc), 3×10^{-2} atoms/cm^3. The theory, among those proposed for the origin of high-velocity gas, that leads most directly to prediction of the existence of such a shell of infalling material is that of Oort (1970), in which the inflow of gas is considered to be the remnant of the conditions that led to the formation of the Galaxy. (auth)

33026 INTERSTELLAR REDDENING LAW AND SPECTRAL CLASSIFICATION. Divan, L. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 12: No. 1, 76-84(Apr 1971).

The law of interstellar reddening was re-examined; special attention was given to the ultraviolet spectral range, from the Balmer jump to the limit of atmospheric transparency (about 3130 Å), because theoretical studies predict large variations of the reddening law with grain models in this region. Accurate spectral type corrections are necessary and the procedure by which they can be obtained is described. The method was applied: 1) to three stars in Perseus: no significant difference with the Cygnus reddening law was found; 2) to four stars in the Orion association. The three brightest stars of the Trapezium were observed separately; although their spectral types differed, they exhibited the same abnormal reddening law which therefore is probably of interstellar origin. A Trapezium type ultraviolet reddening law was also found as far as nine minutes of arc from θ_1 Ori, for the star HD 37061; thus, the abnormal dust may exist in the whole nebula, and not only in the immediate vicinity of the hottest stars. The same conclusion has been drawn by Lee (1968), from infrared measurements. (auth)

Cosmology

33027 ANTIMATTER AND ASTROPHYSICS. Puget, J. L. L. (Univ. of Maryland, College Park). Nature (London) Phys. Sci.; 230: 173-5(19 Apr 1971).

Starting from the general hypothesis that there are equal amounts of matter and antimatter in the Universe, gathered in separated regions with characteristic length equal to galactic or galactic cluster dimensions, an attempt is made to compute the astrophysical consequences and compare them with experimental results, and also to look for new experimental tests. The first need is to compute the cross sections for annihilation under astrophysical conditions, and the principal results are summarized. Equations are also given for computing the annihilation rate in the layer between a matter region and an antimatter region, for which there are three components, coming from $p-\bar{p}$, $p-\bar{H}$ and $H-\bar{H}$ collisions. In particular, the γ-ray flux and spectrum derived from the annihilation process are discussed. There appears to be no obvious contradiction between the general hypothesis and the experimental results for γ-ray flux. The slope of the expected spectrum is determined not only by cosmology but also by the physical processes that control the annihilation rate. (UK)

33028 ROTATING DISKS IN ASTROPHYSICS. Cameron, A. G. W. Comments Astrophys. Space Phys.; 3: 59-64(Mar-Apr 1971).

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When rotation dominates, as in a spiral galaxy, it is necessary to treat the properties of a flat thin disk. In this case the gravitational potential typically depends as much on the distribution of matter exterior to a given point as it does on the interior distribution. A great deal of effort has gone into calculation of the orbits of stars in such a flattened-disk distribution of matter. More recently, the properties of rotating disks are being encountered in other areas of astrophysics. Some of these other applications are briefly discussed. (W.D.M.)

33029 COSMIC BACKGROUND RADIATION AT $\lambda = 3.3$ mm. Millea, M. F.; McColl, M.; Pedersen, R. J.; Vernon, F. L., Jr. (Aerospace Corp., Los Angeles). Phys. Rev. Lett.; 26: 919-22 (12 Apr 1971).

Ground-based measurements of the cosmic-background radiation at $\lambda = 3.3$ mm were made at two high-altitude sites. A weighted average of the two measurements corresponds to a blackbody temperature of 2.61 ± 0.25 K. (auth)

33030 SOME UNSOLVED PROBLEMS IN ASTROPHYSICS. Bahcall, John N. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Astron. J.; 76: 283-90(May 1971).

The theoretical and observational situation with regard to solar neutrinos is reviewed and some of the implications of the discrepancy between theory and observation are discussed. A definition is suggested for compact luminous objects (CLO's) and various proposals for the energy source of CLO's are reviewed. The observational situation and opportunities with regard to the association of CLO's (or QSO's) with galaxies are outlined. The absorption lines observed in large-redshift CLO's are divided tentatively into two classes whose origin is discussed. A number of critical observations are suggested to test various unorthodox ideas. (auth)

33031 DENSITY OF MATTER IN THE FORM OF GALAXIES. Shapiro, Stuart L. (Princeton Univ., N. J.). Astron. J.; 76: 291-3(May 1971).

From recent redshift data provided by de Vaucouleurs (1964) and Roberts (1970), the density of matter in the form of galaxies is redetermined and its dependence on several "input" parameters and assumptions is analyzed in detail. An interpolation formula for the mass density of both elliptical galaxies (E) and spiral and irregular galaxies (S) brighter than absolute magnitude $M = -13.5$ is derived as a function of Hubble's constant H, the mean galactic absorption coefficient α, and the mass-to-light ratios (M/L). For $H = 100$ km sec^{-1} Mpc^{-1}, $\alpha = 0.24$, $(M/L)_E = 30$, and $(M/L)_S = 7.5$, this formula yields a total mass density of 2.0×10^{-31} gm cm^{-3}. (auth)

33032 GENERAL-RELATIVISTIC BASES OF COSMOLOGY. Karolyhazy, Frigyes (Lorand Eetvoes Univ., Budapest). Fiz. Szemle; 21: 12-16(Jan 1971). (In Hungarian).

An attempt is made to outline the basic principles of modern cosmology for the benefit of readers who have no background in the general theory of relativity, starting with the concept of the expanding Universe. The specific geometric meaning of the space–time system is illustrated by an example involving light signals from a drifting space ship. It is pointed out that, according to the theory of relativity, there is no gravitational field, as such; the so-called gravitational motion represents a free, i.e., inertial movement. The effect of large masses in the system is indicated by the curvature of the space–time system. The absence of local effect is expressed geometrically by considering within a short range all surfaces as planes. Einstein's main contribution lay in his ability to express these relations quantitatively, correlating the data derived from free motion with mass distribution characteristics, such as density, pressure, and pulse. The various cosmological models are outlined, pointing out recent astronomical discoveries that promise to prove the correctness of the assumptions on which the models are based; specifically, Schwarzschild's solution concerning the space around the Sun is mentioned. The features of the so-called open and closed models are indicated. (Review article). (TTT)

33033 EVOLUTION OF STRUCTURE IN THE EARLY UNIVERSE. Chernin, A. D. (Ioffe Inst. of Physics and Tech., Leningrad). Astrophys. Lett.; 8: 31-4(Mar 1971).

Structural elements of the early isotropic Universe are treated as a relic of a hypothetical non-Friedmannian stage of cosmic expansion. This primeval structure evolves eventually to a metagalactic turbulence. (auth)

33034 SPECTRUM OF BACKGROUND LOW-FREQUENCY RADIO EMISSION. Krymkin, V. V. (Inst. of Radio Physics and Electronics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: 199-203(1971). (In Russian).

Brightness temperature measurements of the cosmic radio emission in the range of 20 to 38 Mc were made, using a wide-beamwidth antenna oriented at the zenith ($\delta = 50°$). Data obtained are compared with results of earlier investigations with analogous antennas. Possible reasons for the differences are discussed. (auth)

33035 RADIATION FROM A RELATIVISTIC CHARGE IN A GRAVITATIONAL WAVE FIELD. Dimanshtein, F. A. (Kharkov State Univ.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 159-62(1971). (In Russian).

Mathematical analysis was made of the variations of the emission from a relativistic charge moving around a surface with a steady velocity specified by the interaction between the radiation and a gravitational wave. (R.V.J.)

33036 GRAVITATIONALLY COLLAPSED OBJECTS OF VERY LOW MASS. Hawking, Stephen (Cambridge Univ., Eng.). Mon. Notic. Roy. Astron. Soc.; 152: No. 1, 75-8(1971).

It is suggested that there may be a large number of gravitationally collapsed objects of mass 10^{-5} g upwards which were formed as a result of fluctuations in the early Universe. They could carry an electric charge of up to ± 30 electron units. Such objects would produce distinctive tracks in bubble chambers and could form atoms with orbiting electrons or protons. A mass of 10^{17} g of such objects could have accumulated at the center of a star like the Sun. If such a star later became a neutron star there would be a steady accretion of matter by a central collapsed object which could eventually swallow up the whole star in about ten million years. (auth) (UK)

33037 POSSIBILITY OF A 44A LINE COMPONENT IN THE DIFFUSE COSMIC X-RAY FLUX. Lampton, M.; Green, D. W.; Bowyer, C. S. (Univ. of California, Berkeley). Nature (London); 230: 448-9(16 Apr 1971).

In previous investigations of the diffuse cosmic x-ray intensity in the 0.25-keV band it was assumed that the incident x rays are continuously distributed in energy over the band passes of the detectors, and results disagreed. The present authors, in reinterpreting the existing data, considered the possibility of line emission (possibly carbon K_α) being superposed on the cosmic x-ray continuum, leading to a reduction in the discordance of the reported fluxes. New data should be examined for this possibility as they become available. If the observed 0.25-keV radiation is, in fact, line emission, it is important to determine the location of the emitting matter. The source must lie predominantly beyond the Galaxy, and must be localized within $Z = 0.1$. A possible source of line emission is interstellar or intergalactic matter that contains at least a small proportion of C. Carbon K shells photoelectrically absorb cosmic x rays and a fraction of the absorption is followed by fluorescent x-ray emission. It is concluded that the reported intensities of the low-energy diffuse x-ray background flux indicate a systematic dependence on counter-window thickness. This dependence is not easily explained in terms of continuum radiation, or as an instrumental effect, but can be ascribed to 44 Å line emission with an intensity of 25 photons per (cm^2 sec ster). (UK)

33038 OBSERVATION OF AN EMISSION FEATURE AT ≈1.7 cm^{-1}. Beery, J. G.; Martin, T. Z.; Nolt, I. G.; Wood, C. W. (Univ. of Hawaii, Honolulu). Nature (London) Phys. Sci.; 230: 36-7(8 Mar 1971).

Muehlner and Weiss (Phys. Rev. Lett. 24: 742 (1970)) reported balloon measurements in three spectral regions between 1 and 0.5 mm that are not inconsistent with a 3K blackbody on which is superposed a strong emission line between 10 and 12 cm^{-1}. In the present communication, spectral measurements in the 8 to 15 cm^{-1} region are reported that were designed to look for any such emission lines and to separate them from atmospheric lines. The equipment used comprised a 24-inch optical telescope, a Michelson interferometer, and a doped Ge bolometer cooled to 0.4K with a liquid ^{3}He cryostat, at the Mauna Kea site in the early morning of June 15 and 16, 1970. The data presented are based on ten interferrograms and their resultant spectra and a sky emission spectrum is shown; the equivalent blackbody temperature of observed emission features was readily obtained. Features were observed at about 11.7 cm^{-1} in all the spectra, and their strengths were studied as a function of air mass; the air mass dependence indicated that the feature was probably of atmospheric origin. The most likely source of the feature is thought to be N_2O, which has a $J = 14 \rightarrow 13$ line at 11.7 cm^{-1}, the abundance being calculated as 6.7 cm–atm. of N_2O. No isotropic features were observed of the strength needed to explain observations in the 10 to 12 cm^{-1} region reported by others. (UK)

33039 DEBYE–HUECKEL GRAVITATIONAL POTENTIAL IN THE LEMAITRE UNIVERSE. Gerbal, Daniel (Observatoire de Paris, Meudon, France). Compt. Rend., Ser. A; 272: 701-4 (8 Mar 1971). (In French).

The equation for the Debye–Hueckel gravitational potential in the Lemaitre universe was obtained. (auth) (France)

33040 MIXMASTER UNIVERSE PROBLEM. MacCallum, M. A. H. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 230: 112-13(29 Mar 1971).

From the discussion presented it is concluded that Misner's "Mixmaster Universe" does not exist in classical general relativity (see Misner Phys. Rev. Lett. 22: 1071(1969) and Phys. Rev. 186: 1319(1969)). (UK)

33041 BLACK HOLES IN THE DICKE–BRANS–JORDAN THEORY OF GRAVITY. Thorne, Kip S.; Dykla, John J. (California Inst. of Tech., Pasadena). Astrophys. J.; 166: No. 2, L35-8(1 Jun 1971).

Strong evidence is presented in support of a conjecture by Penrose that, in the Dicke–Brans–Jordan theory of gravity, relativistic gravitational collapse in three dimensions produces black holes identical to those of general relativity. (auth)

33042 SIGNATURE OF A PULSAR ON THE DIFFUSE X-RAY BACKGROUND. Silk, Joseph (Univ. of California, Berkeley). Astrophys. J.; 166: No. 2, L39-44(1 Jun 1971).

The early luminosity of young pulsars in supernova remnants can plausibly account for both the observed flux and spectral form of the diffuse x-ray background. A small, but not insignificant, fraction of the x-ray luminosity of the central pulsar is converted into K-series x-ray photons, emitted predominantly by iron-group ions. This leads to the prediction of a line feature in the diffuse component between 6 and 8 keV. (auth)

33043 NEWTONIAN MODEL FOR THE CREATION OF A HIERARCHICAL COSMOLOGY. Haggerty, M. J. (Univ. of Texas, Austin). Astrophys. J.; 166: No. 2, 257-64(1 Jun 1971).

A family of models for the creation of a hierarchy of clusters within clusters is proposed, which involves only gravitational interactions. The basic mechanism is the irreversible creation of correlational energy proposed by Prigogine and Severne. Starting with the proto-globular clusters of Peebles and Dicke, with a global density evolving according to the Newtonian Friedmann model, reasonable qualitative agreement is obtained with de Vaucouleurs's data. Reasons for the remaining discrepancies are suggested. (auth)

33044 PRIMORDIAL VARIATIONS IN THE COSMIC ABUNDANCE OF HELIUM. Silk, Joseph (Univ. of California, Berkeley). Astrophys. J.; 166: No. 2, 249-56(1 Jun 1971).

Primordial temperature fluctuations at early epochs in a Friedmann universe may be responsible for producing spatial variations in the cosmic abundance of helium. The sense of this variation is always to reduce N(He)/N(H) below the value predicted in a homogeneous and isotropic fireball. Within the Galaxy, and in nearby galaxies, the amplitude of this variation may be only 20 or 30%, although a larger effect may occur in more active regions, such as quasi-stellar sources. (auth)

33045 GENERAL RELATIVISTIC BAROMETRIC FORMULAE. Dehnen, H.; Obregon, O. (Univ., Konstanz, Ger.). Astron. Astrophys.; 12: No. 1, 161-4(Apr 1971).

The general relativistic barometric formulas of matter were calculated for several equations of state. In case of the isotropic radiation field and the ideal gas, no finite surfaces exist. (auth)

33046 NUCLEON–ANTINUCLEON ANNIHILATION COEFFICIENT. Aldrovandi, S. M. V.; Puget, J. L. (Institut d'Astrophysique, Paris). Astron. Astrophys.; 12: No. 1, 126-35(Apr 1971).

The mean value $\langle \sigma v \rangle$ was calculated for different processes of proton–antiproton annihilation, over a large range of temperature. The mechanisms considered were annihilation in flight and annihilation from a $p\bar{p}$ bound state created by means of radiative capture or three-body recombination collision or atomic collisions. The annihilation and radiative cascade probabilities in protonium were also studied. (auth)

Planetary Phenomena

33047 IS PLUTO AN IRON-RICH PLANET? Manning, P. G. (Dept. of Energy, Mines, and Resources, Ottawa). Nature (London); 230: 234-5(26 Mar 1971).

Reference is made to the suggestion by Hoyle and Wickramasinghe (Quart. J. Roy. Astron. Soc., 1: 28(1960)) and (Nature, 217: 415(1968)) that the planets were formed in a hot polar centrifuge, and that the compositions of the more dense Fe-bearing inner planets may be due essentially to thermal fractionation. The refractories MgO, Fe, and SiO_2, which represent the principal elements, condense first at about 1500K. The composition of Pluto is considered to be crucial to the validity of the nebular centrifuge theory since, from its position in the solar system, the theory requires that Pluto should not be Fe-rich. A study is described of the reflectance and absorption spectra of Pluto and Fe-bearing terrestrial silicates, respectively, from which it is concluded that Pluto may well be Fe-rich, at least at its surface. (UK)

33048 INERT GASES FROM APOLLO 11 AND APOLLO 12 FINES: REVERSALS IN THE TRENDS OF RELATIVE ELEMENT ABUNDANCES. Yaniv, A.; Heymann, D. (Rice Univ., Houston, Tex.). Earth Planet. Sci. Lett.; 10: 387-91(Mar 1971).

On the basis of the $^4He/^{20}Ne$ ratios in feldspathic particles from Apollo 11, basaltic fragments from Apollo 11, and magnetic separates from Apollo 12 fines, one expects the former to have the highest, and the Apollo 12 material to have the lowest $^{84}Kr/^{132}Xe$ ratios. This is not the case; the $^{84}Kr/^{132}Xe$ ratios from sample 12070 are substantially greater than those from the feldspathic and basaltic fragments in 10084. The trend reversal in the feldspathic particles could be due to the trapping of genuine primordial lunar Kr and Xe. The reversal in the Apollo 11 basaltic fragments might be due to periodic near-quantitative loss of the lighter gases by impact heating, with the Apollo 11 fines containing a relatively large proportion of strongly heated fragments. (auth)

33049 SUPER-HEAVY ELEMENTS IN EXTRATERRESTRIAL SAMPLES. Bhandari, N.; Bhat, S. G.; Lal, D.; (and others) (Tata Inst. of Fundamental Research, Bombay). Nature (London); 230: 219-24(26 Mar 1971).

It is concluded from fossil track studies in several meteorites and in lunar dust that superheavy ($Z > 110$) transuranic elements were present when these objects solidified. (auth) (UK)

33050 SURFACE-RELATED MERCURY IN LUNAR SAMPLES. Reed, G. W.; Goleb, J. A.; Jovanovic, S. (Argonne National Lab., Ill.). Science; 172: 258-61(16 Apr 1971).

Lunar samples contain mercury, which may be volatilized at lunar daytime temperatures. Such mercury may constitute part of the tenuous lunar atmosphere. If mercury can escape from the atmosphere by a nonthermal mechanism, an interior reservoir or exterior sources (such as meteorite infall or solar wind, or both) are required to replenish it. Core samples exhibit an increase in surface-related mercury with depth, which suggests that a cold trap exists below the surface. The orientation of rocks on the lunar surface may be inferred by differences in the amounts of surface-related mercury found on exterior and interior samples. (auth)

33051 METALLIC INTERIORS AND MAGNETIC FIELDS OF JUPITER AND SATURN. Smoluchowski, R. (Princeton Univ., N. J.). Astrophys. J.; 166: No. 2, 435-9(1 Jun 1971).

An earlier proposal that the deep metallic interior of Jupiter is liquid is evaluated quantitatively on the basis of its recent models. It appears that the high magnetic field of this planet can be generated by a hydromagnetic–dynamo mechanism in this metallic liquid but not by a similar mechanism operating in the external molecular layer. The absence of a comparable high field on Saturn results from the expected absence of a liquid metallic interior as deduced from the same basic model and the same physico-chemical considerations including diffusion and differentiation. (auth)

Atomic and Molecular Physics

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 32232, 32846, and 33921.

33052 DEPENDENCE OF SPUTTERING EFFICIENCY ON ION ENERGY AND ANGLE OF INCIDENCE. Andersen, H. H. (Univ. of Aarhus, Denmark). Radiat. Eff.; 7: 179-86(Feb 1971).

Earlier measurements of sputtering efficiency of polycrystalline targets (fraction of impinging ion energy leaving the target through sputtering and backscattering) were extended to higher energies. Lead and copper targets were bombarded with several different projectiles with energies between 80 and 1200 keV. The sputtering efficiency decreases with increasing energy. This decrease is ascribed to the combined influence of changes in the scattering cross section with energy and to electronic stopping. The results may be described as a function of the mass ratio M_2/M_1 and the reduced energy ϵ only. The sputtering efficiency was measured as a function of angle of incidence of the bombarding ions. To

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ensure complete collection of sputtered and backscattered particles, it was possible to cover only the region of incidence angle from 0° to 45°. Targets of copper, silver, and lead were investigated with 17 different ion–target combinations. The sputtering efficiency increased with angle of incidence. This increase is described well by a simple interpolation formula by Sigmund. (auth)

33053 SECONDARY EMISSION FROM RbBr, Se, AND CdTe FILMS BOMBARDED BY SODIUM IONS AND ATOMS. Arifov, U. A.; Flyants, N. N.; Rakhimov, R. R. (Inst. of Electronics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 45-8(1970). (In Russian).

In order to determine the mechanism of kinetic electron emission of solids during bombardment by a fast atomic particle, comparative studies were made of electron emission from dielectric and semiconductor films. Electron emission from RbBr, Se, and CdTe films bombarded by sodium ions and atoms at 30 to 2500 eV was studied, using films coated on backing degassed by heating up to 2200°K. Factors of the secondary electron emission during bombardment of RbBr, Se, and CdTe by sodium (γ) ions and (γ_0) atoms as functions of energy E_0 of bombarding particles showed that for all films the coefficients γ and γ_0 increased with the energy E_0. Moreover, it was found that electron emission from dielectric films bombarded by alkali atoms was more efficient than during bombardment by ions. The charge of bombarding particles did not influence the electron emission because the intensive electron exchange between the metal and incoming particle resulted in identical charge in ions and atoms at the moment of collision. (R.V.J.)

33054 MECHANICAL VELOCITY DISCRIMINATOR FOR FAST NEUTRAL MOLECULAR BEAMS. Sheldon, J. W. (Florida State Univ., Tallahassee); Manista, E. J.; Tischler, R. F. J. Phys., E (London); 4: No. 5, 395-7(May 1971).

The transmission characteristics of a mechanical velocity discriminator are analyzed, and a discriminator design is described in which the ratio (minimum velocity of transmitted beam)/(rotor speed) = 5.99×10^3 cm rev^{-1}. Preliminary results of its operation in conjunction with a fast cesium atom beam are presented. (auth) (UK)

33055 DEVICE FOR IONIZATION OF MATERIAL VAPORIZED BY AN ELECTRON BEAM. Belevskii, V. P.; Koptenko, V. M. Instrum. Exp. Tech. (USSR) (Engl. Transl.); No. 4, 1176-8(Jul-Aug 1970).

Translated from Prib. Tekh. Eksp.: No. 4, 188-90(Jul-Aug 1970).

The device described increases the degree of ionization of material vaporized by an electron beam (up to about 0.5% in the forward flow of vaporized atoms). The possibility of using this device for applying thin films and ohmic contacts and for producing ion beams is shown. (auth)

33056 CHARGE EXCHANGE BALANCE AND DEPOLARIZATION PHENOMENA IN THE CASE OF CHARGE EXCHANGE OF POLARIZED PARTICLE BEAMS IN GASES. Witte, J. (Univ., Erlangen, Ger.). Nucl. Instrum. Methods; 88: 105-7(1970). (In German).

For any charge-exchange process of a particle beam in a gas, the fractions of the positive, negative, and neutral beam components are calculated, dependent on the target thickness. The cross sections involved must be known; they can, however, be related to easily measurable quantities. For an originally polarized particle beam also, the polarizations of the beam components are calculated; they depend on the cross sections and the target thickness, as well as on the magnetic field present in the charge-exchange volume. (auth)

33057 SELECTIVE X-RAY GENERATION BY HEAVY IONS. PART 1. THE USE OF ENERGETIC HEAVY IONS TO GENERATE CHARACTERISTIC X-RAYS FROM ELEMENTS IN A SELECTIVE MANNER. Cairns, J. A.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 7: 163-6 (Feb 1971).

The selective generation of characteristic x rays during heavy-ion bombardment of solids is briefly described. The principles can be understood in terms of the Fano–Lichten model which postulates that, during heavy-ion collisions, interactions occur between the electronic systems of the target and projectile atoms, leading to electron promotions and consequent inner-shell vacancies. The resultant x rays have the advantage of being essentially free from the continuous background radiation that accompanies x rays produced by electron bombardment. It is shown how the characteristic x rays of certain elements may be generated in a selective manner by bombardment with an appropriate heavy ion of optimum energy. The resultant technique is particularly applicable to the analysis of elements located on or near surfaces and may, therefore, be used for the elucidation of distribution profiles of ion-implanted elements. (auth)

33058 LOW TEMPERATURE MOLECULAR BEAM SOURCE. Code, R. F.; Ramsey, N. F. (Harvard Univ., Cambridge, Mass.). Rev. Sci. Instrum.; 42: No. 6, 896-7(Jun 1971).

The cooling system and temperature control system for a low-temperature molecular beam source for beams of hydrogen isotopes are described. (W.H.K.)

33059 LOW-CURRENT LOW-ENERGY-SPREAD DUOPLASMATRON ION SOURCE. Steinberg, M. (Ithaca Coll., N. Y.). Rev. Sci. Instrum; 42: 354-5(Mar 1971).

The design and operation of a simple duoplasmatron particularly suited for low-energy atomic ion scattering experiments are described. With permanent magnets and air cooling, it produces ion currents of about 100 μA having an energy spread of only a few electron volts. (auth)

33060 MOLECULAR BEAMS OF SHORT LIVED RADIOACTIVE NUCLIDES. Grover, J. R.; Kiely, F. M.; Lebowitz, E.; Baker, E. (Brookhaven National Laboratory, Upton, N. Y.). Rev. Sci. Instrum; 42: 293-302(Mar 1971).

The advantages of the use of molecular beams labeled with short lived ($T_{\frac{1}{2}} \approx 10^{-5}$ to 10^{-1} sec) nuclides in crossed-beam studies of molecular interactions are discussed. Theoretical expressions useful for the design of effusive sources of such beams are presented. Experiments to verify the theory and develop apparatus capable of generating usefully intense beams are described, with particular reference to beams of HAt made with 0.032-sec ^{217}At. Beams of 4×10^5 molecules/min incident on a spot 0.4 cm in diameter, 2.5 cm from the collimator, and with angular divergence of 4° have been achieved. (auth)

33061 GENERATION OF BEAMS OF CHARGED PARTICLES WITH TRANSVERSE ENERGY. Jancarik, J. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 19: 964-73(1969).

The operation and construction of an electron gun designed to form beams with variable transverse energy and a variable spread of magnetic moments are described. Transverse energy is acquired by the electrons as the beam passes through a weakly non-adiabatic magnetic step, and in an adiabatic motion through a growing magnetic field. The small spread of magnetic moments of the beam electrons is achieved by fulfilling the so-called focusing conditions, which ensures that the spread of moments resulting from different initial radii of the particles is compensated by their initial radial velocities. (auth)

Atomic and Molecular Properties

Refer also to abstracts 32922, 32929, 32994, 33491, and 33832.

33062 (RFP-Trans-71) RECOIL ATOMS OF RADIOACTIVE BODIES. Goldstein, L. Translated for Dow Chemical Co., Golden, Colo., from J. Phys. Radium; 8: 316-20(1937). 13p. Dep. NTIS.

Disintegration of the nucleus of the radioactive atom accompanied by the emission of a charged particle disturbs the state of this atom previous to disintegration. This disturbance has two aspect limits: the first corresponds to an adiabatic disturbance in the sense that the field of the nucleus where the atomic electrons are found varies, and the second is related to the collision of the particle going through the atom and its electrons. An order-of-magnitude estimate is obtained of the probabilities relative to the possibilities that control the state in which the recoil atom is left after disintegration by studying the effects due to the adiabatic disturbance alone caused by the charge variation of the nucleus. Discussion of the criterion, relative to the slow or fast character of the disturbance, leads to the recognition that the electrons in the outer layers of the atom experience a rapid disturbance, which essentially limits the possibility of excitation or ionization to these electrons with a relatively unchanged probability. These probabilities are approximately determined within simple limits. (auth)

33063 EUROPIUM LUMINESCENCE IN RARE EARTH COMPOUNDS BY INTER ION EXCITATION USING ^{147}Pm. Babusiaux, Anne; Baron, Monique; Loriers, Jean (CNRS, Bellevue, France). pp 581-8 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From International symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.I).

Promethium-147 is a β emitter used for exciting the europium fluorescence in rare earth compounds such as yttrium oxide, yttrium vanadate, or lanthanum oxysulfide. Interesting results

are obtained when ^{147}Pm is incorporated in the luminescent molecule itself. The preparation of the active compounds is made in dry boxes, and involves first the combined precipitation of both promethium and europium with the rare earth element of the matrix, firing the precipitate, and then blending the resulting oxides with other starting reagents, and finally heating the mixture at high temperature to form the phosphor. Self-luminescent compounds having an activity of about 1 Curie/g were prepared. Their fluorescence spectra are characteristic of the Eu^{3+} ion; the relative intensities of the radiative transitions originating from the $^5D_0$ and $^5D_1$ resonance levels are quite similar to those observed by cathode-ray excitation. (auth) (France)

33064 INVESTIGATION OF rf-INDUCED 3P–3D TRANSITIONS IN He^+. Baumann, M.; Eibofner, A. (Univ., Tuebingen, Ger.). Phys. Lett.; 34A: 421-2(19 Apr 1971).

Radio-frequency-induced transitions between $3P_{\frac{3}{2}}$ and $3D_{\frac{3}{2}}$ Zeeman sublevels in He^+ were detected. From the position of the line center of the $P_{\frac{3}{2}}$ ($m = \frac{1}{2}$) ⟷ $D_{\frac{3}{2}}$ ($m = \frac{1}{2}$) transition, the splittings $3P_{\frac{3}{2}} - 3D_{\frac{3}{2}} = (17265 \pm 15)$ MHz and $3P_{\frac{3}{2}} - 3D_{\frac{5}{2}} = (75 \pm 15)$ MHz were deduced. (auth)

33065 EXPERIMENTAL DETERMINATION OF THE INNER STERNHEIMER SHIELDING FACTOR R_{5f} OF AN ACTINIDE. Dunlap, B. D. (Argonne National Lab., Ill.); Kalvius, G. M.; Shenoy, G. K. Phys. Rev. Lett.; 26: 1085-8(3 May 1971).

The comparison between experimental values of the electric field gradient in neptunyl and uranyl complexes allows the derivation of a simple expression for the inner Sternheimer factor in Np. Its evaluation using relativistic expressions for the hyperfine interactions gives the result $R_{5f} = 0.35 \pm 0.1$. An early theoretical estimate is in poor agreement with this number. (auth)

33066 DETERMINATION OF THE IONIZATION POTENTIALS OF ATOMIC URANIUM BY THE ELECTRON-IMPACT METHOD. II. MEASUREMENT OF THE SECOND, THIRD, AND FOURTH IONIZATION POTENTIALS OF URANIUM. Emel'yanov, A. M.; Khodeev, Yu. S.; Gorokhov, L. N. (High Temperature Inst., Moscow). High Temp. (USSR) (Engl. Transl.); 8: 478-83(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 508-13(May-Jun 1970).

The potentials of doubly, triply, and quadruply ionized uranium were measured by the electron impact method: 17.81 ± 0.37; 37.64 ± 0.16; 75.3 ± 1.0 eV. The experimental curves of the efficiency of double and triple ionization (IEC) within the range of 7 to 10 V from the threshold are satisfactorily approximated by quadratic and cubic parabolas. The structure of the IEC with formation of a quadruply charged uranium ion is obviously connected with Auger ionization. The second, third, and fourth ionization potentials are 11.6 ± 0.4, 19.8 ± 0.3, and 36.7 ± 1.0 eV. (auth)

33067 LINE BROADENING OF URANYL SALTS AT LOW TEMPERATURE. Lodato, V. A. (Gulf General Atomic Inc., San Diego, Calif.). J. Phys. Chem. Solids; 32: No. 5, 1087-90 (May 1971).

A model is developed for the energy transfer between uranyl ions for the resonant and nonresonant cases. The periods of excitation transfer are estimated and the spectral broadening of the resonant line is examined in terms of the excitation transfer between ions. The question of whether the initial excitation is due to dipole or quadrupole radiation is resolved. (auth) (UK)

33068 VIBRATION SPECTRA AND DEBYE TEMPERATURES ON TRANSITION METALS. Sangal, S. K.; Sharma, P. K. (Allahabad Univ., India). Acta Phys. Acad. Sci. Hung.; 29: No. 2-3, 107-16(1970).

The vibration spectra and specific heats of three body-centered cubic transition metals, α-iron, tungsten and molybdenum were calculated from Bhatia's model of electron–lattice interaction by considering second-neighbor interionic interactions. The force constants are determined from the experimental elastic constants and one measured frequency. The calculated specific heats are compared with the available experimental data by computing the equivalent Debye temperature as a function of temperature and the agreement with experiment is reasonably satisfactory. (auth)

33069 ISOTOPIC SHIFT CONSTANT OF Nd. SCREENING EFFECT OF THE 5d ELECTRON. Gerstenkorn, Simon; Helbert, Jean-Marie (CNRS, Orsay, France). Compt. Rend., Ser. B; 271: 626-9(28 Sep 1970). (In French).

The screening effects of the 5d electron on the ns^2 internal shells are taken into account. The experimental constant C_{exp} e ($^{142}Nd - ^{144}Nd$) evaluated by Noldeke is shown to be overestimated by about 10%. The screening effects of the 5d electron on the ns^2 internal shells account for about 20% of the volume effect due to the 6s electron only. (auth) (France)

33070 INFLUENCE OF ROTATION ON THE LIFETIME OF PREDISSOCIATED MOLECULES. Comes, F. J.; Schumpe, G. (Univ., Bonn). Z. Naturforsch.; 26a: 538-46(Mar 1971). (In German).

The D $^1\Pi_u - X^1\Sigma_g^+$ system of H_2 and D_2 shows strong predissociation. High-resolution measurements on the line widths of isolated absorption lines were carried out, showing the influence of rotation on the predissociation probability of the corresponding rotational states. Their lifetime decreases with increasing rotation of the molecule and with decreasing mass due to the coupling of electronic and rotational motion. Both results are in excellent agreement with theoretical predictions given by Kronig. The shape of the absorption lines broadened by predissociation was found to be typically asymmetric. They are of the Beutler type, well known from the autoionization of the rare gases. (auth)

33071 ATOMIC-K-X-RAY INTENSITY RATIOS. Schult, O. W. B. (Technical Univ., Munich. Danish Atomic Energy Commission, Risoe). Z. Naturforsch.; 26a: 368-70(Mar 1971).

Experimental K x-ray intensity ratios $K\alpha_2/K\alpha_1$, $K\alpha_3/K\alpha_1$, $K\beta_1/K\alpha_1$, $K\beta_2/K\beta_1$, $K\beta_3/K\beta_1$, $K\beta_4/K\beta_1$, and $K\beta_5/K\beta_1$ were determined for several elements with $63 \leq Z \leq 92$. These ratios agree very well with the results of a fully relativistic calculation of transition probabilities by Rosner and Bhalla. The theoretical values are tested with an accuracy of better than 1% for the ratios $K\alpha_2/K\alpha_1$, $K\beta_2/K\beta_1$ and $K\beta_3/K\beta_1$. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 33425.

33072 POSITRON ANNIHILATION IN IONIC CRYSTALS. Bartenev, G. M.; Tsyganov, A. D.; Prokop'ev, E. P.; Varisov, A. Z. (Moscow State Pedagogical Inst.). Usp. Fiz. Nauk; 103: 339-54(Feb 1971). (In Russian).

The annihilation process for positrons is undoubtedly complex as evidenced by the experimental characteristics such as the positron half-life, angular correlation of the annihilating radiation, and the relative velocity of coincidence counting of three γ-quanta. An analysis of the positron state in a crystal is presented to account for the experimental data. 120 references. (tr-auth)

33073 POSITRONIUM ANNIHILATION IN MAGNETIC FIELDS UP TO 21 kG. Colombino, P.; Fiscella, B. (Univ., Turin). Nuovo Cim.; 3B: No. 1, 1-14(11 May 1971).

The angular correlation of photons from the two-gamma decay of positrons in some substances (paraffin wax, nylon, teflon, fused quartz, liquid and solid water) was measured in the presence of an external magnetic field up to 21 kG. The narrow-component intensity of the angular spectrum, due to the rate of positronium (Ps) that self-annihilates from the singlet state, is enhanced by the H field. The effect, produced by the magnetic mixing of two spin states of Ps, is shown to be in agreement with theory. Measurements in powdered air-saturated aluminum oxide reveal a different behavior of Ps which can be explained by the ortho-Ps quenching property of the O_2 molecules absorbed. (auth)

33074 ELECTROMAGNETIC SIZES AND SHAPES OF $^{136\ 137\ 138}Ba$, ^{139}La, $^{140\ 142}Ce$, ^{141}Pr, AND ^{142}Nd NUCLEI FROM MUONIC X-RAYS. Thompson, Albert Charles. Pittsburgh; Carnegie-Mellon Univ. (1969). 95p. University Microfilms Order No. 70-17,147.

Thesis.

The muonic x rays of $^{136,137,138}Ba$, ^{139}La, $^{140,142}Ce$, ^{141}Pr, and ^{142}Nd were measured with a high-resolution Ge(Li) detector. The isotope shift of the K(2P–1S) lines for the Ba and Ce nuclei were measured. The values of the magnetic-hyperfine-splitting parameter $A(1S_{\frac{1}{2}})$ of ^{139}La and ^{141}Pr were found to be 1.21 ± 0.09 keV and 1.52 ± 0.06 keV, respectively. The quadrupole moments of ^{137}Ba, ^{139}La, and ^{141}Pr measured from $2P_{\frac{3}{2}} - 1S_{\frac{1}{2}}$ hyperfine structure were found to agree with results from other techniques. The Fermi-charge-distribution parameters, C_0 and t, were measured for ^{138}Ba, ^{139}La, ^{140}Ce, ^{141}Pr, and ^{142}Nd. The skin thickness parameter t was found to increase from $t = 2 \pm 0.15$ F for ^{138}Ba to $t = 2.34 \pm 0.07$ F for ^{142}Nd. The $N = 82$ isotone shift was measured to be about 1.63 times the shift expected with a uniform charge distribution. The staggering parameter for the isotones La and Pr was measured to be about 0.8. (Diss. Abstr. Int., B)

33075 EMISSION OF NEUTRONS FROM MUONIC LEAD AND BISMUTH. Srinivasan, V.; Sundaresan, M. K. (Carleton Univ., Ottawa). Can. J. Phys.; 49: 621-8(1 Mar 1971).

XUM

The emission of prompt neutrons from muonic bismuth observed experimentally is believed to be caused by the radiationless excitation of the target nucleus above the neutron separation energy by muonic transitions of the type np → 1s (n ≥ 3). The work of Zaretskii and Novikov for muon-induced fission in uranium is extended to the case of muonic lead and bismuth. The ratio of rates of radiationless excitation to the radiative transition probabilities is calculated by the surface-current model of Sliv to check random-phase approximation used in the calculation by Zaretskii. The neutron spectrum obtained using this nuclear branching in the cascade calculation is given for lead and bismuth. (auth) (Canada)

33076 INTENSITY MEASUREMENTS OF X-RAY AND NUCLEAR GAMMA-RAY TRANSITIONS IN SOME HEAVY MUONIC ATOMS. Backe, Hartmut (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 241: 435-58(1971). (In German).

Absolute intensities of the 5 → 4 muonic x-ray transition in muonic W, Os, and Bi and relative intensities of other x-ray transitions were measured and compared with cascade calculations. The excitation of several levels in W, Os, Ir, Tl, and Bi nuclei resulting from the muonic cascade process was observed; and absolute excitation probabilities were determined. For the first 2^+ level of ^{188}Os and first $3/2^+$ levels of ^{203,205}Tl the excitation probabilities are larger than calculated. The results are discussed. (55 references) (auth)

33077 MUONIC X-RAYS FROM LIQUID HYDROGEN. Budick, B.; Toraskar, J. R.; Yaghoobia, I. (New York Univ., Bronx). Phys. Lett.; 34B: 539-41(29 Mar 1971).

Lyman radiation was observed from the muonic atoms formed when a beam of muons stops in a liquid hydrogen target. Energies for these x rays lie in the range 1.9 to 2.5 keV. The results are consistent with a ratio of $K_\alpha/\Sigma K = 0.7 \pm 0.2$. In addition, a search was made for x rays from pionic hydrogen by stopping negative pions in liquid hydrogen. No clear evidence for pionic x rays was found. (auth)

33078 OBSERVATION OF MUONIC X-RAYS IN HELIUM GAS AND MEASUREMENT OF THE TWO-PHOTON DECAY RATE OF THE 2s METASTABLE STATE. Placci, A. (CERN, Geneva); Polacco, E.; Zavattini, E.; (and others). Nuovo Cim.; 1A: 445-67(1 Feb 1970).

The yield of the K and L lines of the muonic helium system stopping negative muons in a gaseous helium target (7 atm, 293°K) was measured. The two-photon decay of the ionic metastable 2s state was also observed, and it was found that this system is formed in (3.4 ± 0.7)% of the stopped muons. (auth)

Collision Phenomena

33079 (JAERI-Memo-4195) GENERALIZATION OF EIKONAL APPROXIMATION. Ryufuku, Hiroshi (Japan Atomic Energy Research Inst., Tokyo). Nov 1970. 45p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The eikonal approximation is generalized for application to rearrangement collisions as well as elastic collisions. Calculations are carried out of scattering amplitudes, charge-exchange probabilities, and total cross sections for nuclei B (charge $Z_b e$, mass M_b) incident on hydrogen-like atoms (charge $Z_a e$, mass M_a) with a velocity of v_i in the range $Z_a Z_b e^2/\hbar v_i \lesssim 1$. In this method the transition matrices are calculated, using distorted waves instead of plane waves employed in the Born approximation as the initial state; i.e., the distortion of waves due to the static potential field made by the target atoms is taken into consideration. Results obtained for the charge-exchange process p + H(1s) → H(1s) + p are presented. (auth) (Japan)

33080 (KFK-1256) PRODUCTION OF POLARIZED DEUTERIUM IONS WITH A LAMB-SHIFT SOURCE. Bechtold, V.; Brueckmann, H.; Finken, D.; Friedrich, L.; Hamdi, K.; Seitz, E. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jul 1970. 17p. (In German). (CONF-700417-3). Dep. NTIS (U. S. Sales Only).

From Joint meeting of the German and Dutch physical societies: Eindhoven, Netherlands (Apr 1970).

The production and the selective ionization of metastable hydrogen atomic beams are investigated by different charge-exchange collisions. The experiments aimed at a profitable use of the Lamb shift for the production of polarized-hydrogen-ion beams. The selectivity of the charge-exchange reactions turns out to decrease with increasing energy in the region between 0.5 and 5.0 keV. This general behavior can be understood qualitatively from the pseudo-crossing theory. The production of metastable hydrogen atoms by charge-exchange collisions shows, in different gases, only a high yield if the energy defect of the reaction is small. The experimental results agree qualitatively with calculations for nonresonant charge-exchange collisions. Some characteristic results achieved with the Karlsruhe Lamb-shift source A-LASKA and the application to the production of polarized deuterium ion beams are discussed. (auth)

33081 RESONANCES IN INELASTIC ELECTRON SCATTERING BY ATOMIC HYDROGEN. Oed, A. (Univ., Tuebingin, Ger.). Phys. Lett.; 34A: 435-6(19 Apr 1971).

Resonances in the excitation cross section Q(1s–2s) of hydrogen atoms by electron impact are measured. (auth)

33082 PHOTODETACHMENT OF HYDROGEN NEGATIVE ION: A MANY-BODY APPROACH. Dutta, N. C.; Dutta, C. M. (Univ. of Utah, Salt Lake City). Phys. Lett.; 34A: 369-70 (19 Apr 1971).

The Brueckner–Goldstone many-body perturbation theory is applied to calculation of the photodetachment cross section of H^- Various electron correlation effects associated with the initial and final states are discussed using diagrammatic techniques. (auth)

33083 REMARK ON BORN APPROXIMATION IN THEORY OF ELECTRON–ATOM COLLISIONS. Ob'edkov, V. D. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 150-1(Aug 1970). (In Russian).

The known formulation of the Born approximation is connected with the definite choice of the complete system of the wave functions. Using the unitary transformation of the initial basis, the new approximations for the inelastic transition amplitude can be obtained. Some of the possible approximations corresponding to the first order of the perturbation theory are given. (auth)

33084 PROTON EXCITATION OF VUV RADIATION FROM THE NOBLE GASES. Stewart, Thurman Edward. Lexington, Ky.; Univ. of Kentucky (1970). 129p. University Microfilms Order No. 71-8602.

Thesis.

Protons were used to excite the noble gases He, Ne, Ar, Kr, and Xe and the spectra of emitted photons in the vuv region was measured. It was found that the proton-excited spectra depended on the gas purity, especially in the cases of neon and helium. A new method of monitoring the gas purity almost simultaneously with the emission studies, based on W measurements, was successfully incorporated into the emission experiment. The same gases were excited both by protons and by gas discharges. It is well known that the spectral shape of the discharge-excited spectra depend on the discharge conditions, yet the spectra of purified noble gases induced by protons was found to be stable and reproducible. In most cases the continuous emission spectra emitted as a result of proton excitation differed significantly from the gas discharge-induced spectra. In both cases the spectra depend on the pressure, but in a much less complicated way in the case of proton excitation. (TSS) (Diss. Abstr. Int., B)

Atomic Theory

Refer also to abstract 34141.

33085 RADIATIVE DECAY OF AN ATOM WITH TWO CLOSE-LYING EXCITED STATES. Bali, L. M.; Higgins, R. B. (London Univ.). Phys. Lett.; 35A: No. 2, 95-6(17 May 1971).

The line shape of spontaneous emission of an atom with closely spaced energy levels is determined, using transition operator techniques. (auth)

33086 STATISTICAL MODEL OF ATOMS IN INTENSE MAGNETIC FIELDS. Mueller, R. O.; Rau, A. R. P.; Spruch, Larry (New York Univ., N. Y.). Phys. Rev. Lett.; 26: 1136-9(3 May 1971).

The dimensions R, electron density distributions $n(\vec{r})$, and total ground-state binding energies E of atoms and positive ions (nuclear charge Z, N electrons) in intense magnetic fields are obtained. A variationally formulated Thomas–Fermi-like model is valid for $Z^4 \ll 10^{-9}\ B \ll 10Z^3$ G; the choice $n(\vec{r}) \sim ZR^{-3}\ \sigma^{-4} \exp(-\sigma)$, $\sigma \equiv \gamma^2/R^2$, gives $E \approx -150\ (B/10^{12})^{4/5}\ Z^{7/5}$ eV, for neutral atoms. A crude variational calculation, valid for $B \gg 10^{10}\ Z^3$, gives $E \approx -13.6N\ (Z - 1/3N)^2 \ln^2 (2B/10^{10})$ eV. (auth)

Cosmic Radiation

Refer also to abstracts 33532, 33539, and 33627.

33087 COSMIC RAYS AND COSMIC X RAYS. I. COSMIC RAYS IN THE GALAXY. II. COSMIC RAYS AND EXTRA-GALACTIC OBJECTS. Felten, J. E. (Univ. of California, San Diego, La Jolla). J. Roy. Astron. Soc. Can.; 64: No. 1, 33-49 (Feb 1970).

Aspects of cosmic-ray physics and the physics of particles and fields as they bear upon astronomy, particularly radio and x-ray

astronomy, are discussed. Classical cosmic rays, their motion in the galaxy, possible origins, and relation to radio astronomy and extragalactic objects, as well as cosmic x rays, are considered. (Canada)

33088 COSMIC RAYS AND COSMIC X RAYS. III. THEORIES AND OBSERVATIONS OF COSMIC X-RAY SOURCES. Felten, J. E. (Univ. of California, San Diego, La Jolla). J. Roy. Astron. Soc. Can.; 64: No. 2, 73-89(Apr 1970).

Instrumentation and methods used in the detection of celestial x rays are briefly discussed. Some discrete sources are listed, and theories of x-ray sources are discussed with reference to the sources Sco X-1 and Tau X-1, weaker galactic sources, and extragalactic sources. Possible explanations for diffuse background x radiation are given. (Canada)

33089 TYPE-I VARIATIONS OF EXTENSIVE AIR SHOWERS AT THE SEA LEVEL. Cachon, Andre; Capdevielle, Jean-Noel; Dupuy, Jean (Observatoire du Pic du Midi, Bagneres-de-Bigorre, France. Univ., Toulouse). Compt. Rend., Ser. B; 272: 445-8 (15 Feb 1971). (In French).

The height at which the first nuclear interaction of primary cosmic particles occurs in the atmosphere coincides with the origin of the extensive shower. A simulation method is presented which demonstrates the effect of this origin on the morphology of the shower at sea level, as well as the existence of an upper limit to the relative abundance of the muons generated by primary protons. (auth) (France)

33090 OBSERVATION OF COSMIC GAMMA RAYS. Danjo, Atsunori; (Nagoya Univ., Japan); Ikeda, Masahiko; Makino, Fumiyoshi; Tanaka, Yasuo; Hayakawa, Satio. Tokyo Daigaku Uchu Koku Kenkyusho Hokoku; 6: 340-5(Mar 1970). (In Japanese).

Balloon observation of isotropic cosmic γ rays was performed on Apr. 18, 1969, at Hyderabad, India. The data obtained at altitude 8 mb for 2 hours and 40 minutes were recorded on magnetic tapes. The directional characteristic of the γ-ray counter was improved by taking the difference of counting rate with the shutter open and closed. The γ-ray spectrum obtained is shown and compared with those obtained by Metzger et al. and Vette et al. The observation of the γ-ray from the Crab Nebula failed because of low S/N ratio. Data were obtained concerning the Compton telescope, which is to be carried on the science satellite CORSA. (Japan)

33091 EVIDENCE OF RADIO PULSES AT 2 MHz FROM COSMIC-RAY AIR SHOWERS. Stubbs, T. J. (Univ. of Adelaide). Nature (London) Phys. Sci.; 230: 172-3(19 Apr 1971).

Evidence is presented for 2 MHz emission, obtained using high-speed digital techniques to analyze radio pulses from a total of 100 showers. This is a frequency region for which very contradictory experimental results had previously been obtained. The aerial array employed operated at 1.98 MHz and contained 178 individual half-wave dipoles, with an area of about 1 km^2. A detailed description is given of the equipment setup, including the radio receiver, a voltage-controlled oscillator, a high-speed ten-channel counter, an optical Čerenkov detection system, coincidence detector, etc. The results of a statistical analysis of the counts recorded in each channel are shown graphically; the counts for shower events agreed well with the expected pulse-response curve, and radio pulses of air-shower origin were observed at a high level of statistical significance. The observed signal corresponded to an average field strength of the order of 1 $\mu V/m/MHz$, and by extrapolation this would indicate a field strength of about 500 $\mu V/m/MHz$ for shower primaries $\geq 10^{17}$ eV if, as is generally accepted, the field strength is proportional to the primary energy. A sharp rise at low frequency was verified. (UK)

33092 INTERPLANETARY DECELERATION OF SOLAR COSMIC RAYS. Murray, S. S.; Stone, E. C.; Vogt, R. E. (California Inst. of Tech., Pasadena). Phys. Rev. Lett.; 26: 663-6 (15 Mar 1971).

Observations of solar-flare proton fluxes of low energies (1 to 10 MeV) during the June 7, 1969 event have been used to study the effects of energy-change processes on particles propagating in interplanetary space. It is found that the proton energies are decreasing with time at a rate that is consistent with an exponential-decay time constant of 210 ± 10 hr. Since adiabatic deceleration in a uniform solar wind would result in a faster decay (78 ± 4 hr), additional processes such as Fermi acceleration or a more general deceleration process must be considered. (auth)

Direct Energy Conversion

Refer also to abstracts 32313, 32974, 33291, 33411, 33458, and 34375.

33093 (INR-1242) EFFECTS OF LEAKAGE CURRENTS TO GROUND IN AN MHD GENERATOR WITH UNIFORM GAS. Celinski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 17p. Dep. NTIS (U. S. Sales Only).

Expressions are derived that determine the effects of leakage currents to ground upon the electrical performance of Faraday and Hall-type MHD generators when the leakage resistance is distributed along the channel. Constant gas parameters and constant channel cross section are assumed. The numerical calculation performed for a typical generator has shown that this effect is not too large when the insulation resistance between the electrode and the generator casing is of the order of several thousand ohms. (auth)

33094 (INR-1243) LEAKAGE CURRENTS IN THE FARADAY-TYPE MHD GENERATOR WITH NONUNIFORM GAS. Celinski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 19p. Dep. NTIS (U. S. Sales Only).

One-dimensional gas flow in the presence of the leakage currents is considered. Results of calculations point out that the current–voltage characteristics of the generator may be strongly nonlinear and a gas acceleration mode of operation may be established in the outlet part of the generator channel. The two-dimensional gas flow in the presence of the leakage currents is considered. The possibility of the numerical analysis of such problems by means of the equivalent circuit method is shown. Some interesting effects occurring in such a case are discussed and quantitatively estimated in the numerical example. (auth)

33095 PROCESS FOR REVERSIBLY TRANSFORMING THERMODYNAMIC ENERGY INTO ELECTRIC ENERGY, AND A DEVICE USING THE PROCESS. Bidard, Rene (to Compagnie Electro-Mecanique). French Patent 1,593,757. 1 Jun 1970. Filed 28 Nov 1968. (In French).

This procedure for reversibly transforming thermodynamic energy into an alternating electric current consists of circulating a conducting liquid in a closed circuit, of at least one loop, in a magnetic field. In a first region (designated generating), the liquid is emulsified with a gas. It is then separated from this gas and compressed in a second region (designated consuming). Characteristic are the traveling multipolar magnetic field and the relative velocities of the fluid in relation to the field: the liquid flow is positive with respect to the magnetic field, as in an asynchronous generator, in the generating region, where the emulsion expands and negative, as in an asynchronous motor, in the consuming region, where the liquid is recompressed. The compression gas is introduced into the loop in a first intermediate region between the end of the consuming region and the beginning of the generating region. The expanded gas is separated from the liquid in a second intermediate region between the end of the generating region and the beginning of the consuming region. The velocities of the fluids in these intermediate regions are arranged to be the same as that of the rotating field. Conversely, electrical energy in the form of an alternating current can be converted into thermodynamic energy by compressing the emulsion and withdrawing energy from the region where the liquid is emulsified. A magnetohydrodynamic device utilizing the principles underlined is described. (France)

33096 INVESTIGATION OF EMERGENCY OPERATING MODES OF A MAGNETOHYDRODYNAMIC GENERATOR ON AN ANALOG COMPUTER. Iotkovskii, B. G.; Kirillov, V. V.; Pishchikov, V. I. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 585-9(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 629-33(May-Jun 1970).

The possibility of investigating emergency operating modes of a magnetohydrodynamic generator on analog computers is considered. The effect of short-circuit or disconnection of a portion of the electrodes on the magnetohydrodynamic generator as a whole is investigated for a stipulated pressure differential across the generator. Certain possibilities of controlling the operation of a magnetohydrodynamic generator in emergency situations are considered. (auth)

33097 EFFECT OF CERTAIN FACTORS ON THE EXTERNAL CHARACTERISTICS AND EFFICIENCY OF MAGNETOHYDRODYNAMIC GENERATORS. Gubarev, A. V.; Gurashvili, V. A. High Temp. (USSR) (Engl. Transl.); 8: 590-6(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 634-40(May-Jun 1970).

The effect of one-dimensional inhomogeneities of the plasma conductivity on the characteristics of magnetohydrodynamic generators is considered. Estimates are given of the effect of the viscosity and efficiency of the jet and exit cone on the efficiency of the magnetohydrodynamic generator as a whole. (auth)

33098 POSSIBILITY OF INCREASING THE EFFICIENCY OF CONDENSATION SCHEMES FOR THE LIQUID-METAL MAGNETOHYDRODYNAMIC CONVERSION OF ENERGY. Dukhovlinov,

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S. D. High Temp. (USSR) (Engl. Transl.): 8: 645-7(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.: 8: 680-2(May-Jun 1970).

In the liquid–metal MHD energy-conversion scheme, flow of the working fluid in the generator is produced by the condensation of accelerated vapor on a supercooled liquid, leading to an increase in the temperature of the heat receiver. The effect of nonisothermicity of the condensation process on the efficiency is considered when the temperature at which the heat is removed in the cycle varies with the heat-receiver temperature. The efficiency is increased if the vapor is expanded to a temperature close to that of the liquid at the entry to the mixing chamber, and then the pressure on the rest of the vapor is increased so that the liquid temperature increases, with variation of the flow section profile. The thermodynamic cycle for such a process is discussed, and the possible relative increase in efficiency with nonisobaric condensation is estimated to be on the order of 1.5. An experimental pressure distribution over the mixing chamber length is given, and it is concluded that there are no restrictions in principle on nonisobaric condensation of vapor in a mixing chamber with low-temperature heads. (D.L.C.)

33099 NEW PROCESS FOR MAGNETOHYDRODYNAMIC CONVERSION AND AN APPARATUS USING THE PROCESS. Le Bouc, Francois (to Institut Francais du Petrole, des Carburants et Lubrifiants). French Patent 1,601,897. 21 Sep 1970. Filed 24 Dec 1968. (In French).

A process for transforming thermal energy into electrical energy is described. It consists of inducing the flow of a high-temperature conducting fluid in a tube; the two opposing walls carry electrodes and are joined by two insulating walls. The tube is placed in a magnetic field whose lines of force are sensibly perpendicular to the electrodes. The tube is fed with a preheated gaseous comburent fluid whose temperature is at least 1500°K. A fuel capable of spontaneously igniting at the flow temperature is introduced into the tube, so as to ensure a sensibly homogeneous distribution of the fuel. This procedure is effected only in a central zone of the tube, the boundaries being the two walls carrying the electrodes and two planes which are sensibly parallel to the respective insulating walls and situated at distances varying between 2.5 and 10%, and more particularly between 3.5 and 5.5% of the distance separating the insulating walls. The comburent fluid can be air, which may or may not be oxygen-enriched, into which an alkaline seed is introduced. (France)

33100 DIRECT ENERGY CONVERSION. Kettani, M. Ali. Addison-Wesley Series in Electrical Engineering. Reading, Mass.; Addison-Wesley Publishing Company, Inc. (1970). 465p. $14.95.

The field of direct energy conversion is placed with respect to energy and development and the physical principles are treated briefly. The following nine methods of direct energy conversion are covered: fusion, magnetohydrodynamics, thermoelectricity, thermionics, fuel cells, photovoltaic cells, electrohydrodynamics, piezoelectricity, and ferroelectricity. Fifteen other methods are touched briefly. (M.H.R.)

33101 CYCLE OF A ONE-COMPONENT LIQUID-METAL MAGNETOHYDRODYNAMIC CONVERTER WITH VAPOR SEPARATION AHEAD OF THE MAGNETOHYDRODYNAMIC GENERATOR AND MIXING OF THE FLOW BEYOND THE MAGNETOHYDRODYNAMIC GENERATOR. Kalafati, D. D.; Kozlov, V. B. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 822-7(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 879-84(Jul-Aug 1970).

A thermodynamic analysis is carried out of the cycle of a magnetohydrodynamic converter scheme with separation of the one-component liquid-metal working substance ahead of the magnetohydrodynamic generator and mixing of the flows beyond it; this allows the basic source of kinetic energy loss with the flow of vapor after separation to be determined. The results obtained allow the effect of a change in the thermodynamic parameters and properties of the working substance on the thermal efficiency of the cycle, the mass efficiency of the separator, and the overall efficiency of a cycle with reversible expansion to be traced for the scheme investigated. The analytical relationships found allowed the determination in explicit form of (a) the optimal values of vapor content in a cycle with reversible expansion, which corresponds to the maximum overall cycle efficiency or the maximum work or power takeoff, and (b) the value of vapor content corresponding to a change in the character of the dependence of the mass efficiency of the separator on the temperature interval of the cycle. (auth)

33102 EFFECT OF LEAKAGES ON THE CHARACTERISTICS OF A MAGNETOHYDRODYNAMIC GENERATOR. Bityurin, V. A. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 828-32(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 885-9(Jul-Aug 1970).

The influence of the mechanism of transverse current leakage in the channels of an MHD generator, in the presence of the Hall effect, on the basic characteristics of the energy conversion is considered. It is shown that for a local shunting mechanism (i.e., for the case in which the leakage current along the channel walls can be shorted, bypassing the electrode and the poorly conducting region of the flow near its surface) the electrical parameters of the flow may differ substantially from the corresponding values calculated on the basis of the widely used model of shunting by a lumped leakage resistance connected in parallel with the load resistance. (auth)

33103 MHD INDUCTION MACHINE WITH INTERNAL COMPENSATION FOR END LOSS. Pierson, E. S. (Univ. of Illinois, Chicago). Energy Convers.; 11: No. 2, 47-53(Jun 1971).

The total length of an MHD induction generator is limited to minimize the viscous loss, and the wavelength should be long to improve the electrical properties, leading to a machine only one or a few wavelengths long. End effects may then significantly reduce the power output and efficiency. The field solution and powers without compensation are summarized, and the low efficiency for typical generator parameters is shown. The previous internal-compensation method is examined critically and shown to yield a maximum efficiency of less than 34% for a one-wavelength-long generator without including viscous and excitation losses; this is clearly unacceptable. This method is then generalized to give a significant improvement in the efficiency, although within the limitations imposed, it does not appear possible to attain the minimum efficiency required for a practical generator. This analysis is also applicable to induction pumps and linear induction motors, although they are not considered here. (auth) (UK)

33104 THEORETICAL INVESTIGATION OF THE PROBLEM OF PREIONIZATION IN A CLOSED-CYCLE MAGNETOPLASMADYNAMIC GENERATOR. Owens, William Raymond. College Park, Md.; Univ. of Maryland (1970). 147p. University Microfilms Order No. 71-10,221.

Thesis.

A two-dimensional theoretical analysis, with nonuniform properties in the presence of combined magnetically induced and applied electric fields, is used to determine the influence of the plasma temperature, pressure, Mach number, magnetic field, seed ratio, electrode separation distance, and current on the terminal voltage of a single pair of pre-ionization electrodes located in a constant-area channel. These results may be used to select plasma properties that will minimize the amount of pre-ionization auxiliary power that must be expended to operate at a desired nonequilibrium level. The plasma is assumed to approach the pre-ionization electrodes in a state of thermal equilibrium. As the plasma flows between the electrodes, the electrons are accelerated by the magnetically induced and applied electric field, which increases the electron temperature above the heavier species of the plasma. The nonlinear coupled governing equations are solved numerically, using an iterative relaxation technique. The results of this study are based on a cesium-seeded helium plasma. Ion slip was found to be an important consideration especially with high magnetic fields. Plasma instabilities with Hall parameters greater than about three were found to have a very significant effect on the terminal voltage, however, the influence of these instabilities decrease for Hall parameters greater than fourteen which was also experimentally observed by Brederlow and Zinko for an argon–potassium plasma. The amount of pre-ionization power increases as the plasma temperature decreases and as the pressure increases. The effect of thermal convection of the electron energy or "blowing" is significant at high Mach numbers especially in the absence of an applied magnetic field. The optimum cesium seed fraction was found to be about 1.3%. Inelastic electron energy losses are a significant consideration particularly for small-geometry channels. (TSS) (Diss. Abstr. Int., B)

Fluid Physics

Refer also to abstracts 33094 and 33099.

33105 TURBULENT DIFFUSION OF CHARGES ARISING FROM UNIPOLAR INJECTION INTO AN INSULATING LIQUID. Hopfinger, Emil J. (Univ., Gernoble, France); Gosse, Jean-Pierre. Compt. Rend., Ser. B; 271: 316-19(3 Aug 1970). (In French).

Unipolar charge injection between two plane parallel electrodes immersed in nitrobenzene was studied. When the applied potential was sufficiently high (>10^3 V) the liquid assumed a turbulent motion shortly after switching on (~1 ms). In this case, the charge transport regarded from a Eulerian point of view can be described by a diffusion equation. This analysis was in good agreement with experimental results and gave a physical explanation to the high values of mobility observed for the carriers. (auth) (France)

33106 PROBLEM ON ELECTRIC CURRENT VORTEX AT ENTRANCE OF ANISOTROPIC CONDUCTING MEDIA IN MAGNETIC FIELDS. Emets, Yu. P. Prikl. Mat. Mekh.; 35: 229-37 (Mar-Apr 1971). (In Russian).

Studies were made of an electrical field in the flow of moving media with a tensor conductivity produced by the Hall effect in the region of a fast-changing external magnetic field. The structure of the electric current vortex formed in this zone, electromagnetic forces, and Joule dissipation of induced currents are determined mainly by the velocities and physical properties of moving media with the parameters (electric conductivity and Hall effects) varying with the changes in magnetic field. Solutions of the problem of conducting media in motion in inhomogeneous external magnetic fields can be applied to the case of the end losses in magnetohydrodynamic channels with plasma current at the entrance and the exit of the magnetic field. (R.V.J.)

33107 DISTURBANCES IN A VISCO-ELASTIC MEDIUM OF VOIGT TYPE IN CONTACT WITH A LIQUID MEDIUM AND SUBJECTED TO A MAGNETIC FIELD. Basu Mallik, Sukumar (Jadavpur Univ., Calcutta). Indian J. Pure Appl. Math.; 1: 389-95(Jul 1970).

The investigation of the problem of disturbances in a visco-elastic medium of Voigt type in contact with a liquid medium acted upon by a magnetic field forms the chief interest of this note. The electromagnetic equations of Maxwell, equation of elasticity, and the stress–strain relations of Voigt material are used to solve the problem. (auth)

33108 ELECTROSTATIC FIELD INDUCED IN A FORCED VORTEX FLOW OF A VISCOUS AND ELECTRICALLY CONDUCTING FLUID IN PRESENCE OF AN AXIAL MAGNETIC FIELD. Chambarel, Andre; Dorlhac, Francois (College Scientifique Univ., Avignon, France). Compt. Rend., Ser. A; 272: 631-4 (1 Mar 1971). (In French).

A relation is shown to exist between the electrostatic field and the local velocity of a liquid vortex flow in magnetohydrodynamics. Theoretical and experimental results are compared. (France)

33109 THREE-DIMENSIONAL MHD DUCT FLOWS WITH STRONG TRANSVERSE MAGNETIC FIELDS. PART 2. VARIABLE-AREA RECTANGULAR DUCTS WITH CONDUCTING SIDES. Walker, J. S. (Cornell Univ., Ithaca, N. Y.); Ludford, G. S. S.; Hunt, J. C. R. J. Fluid Mech.; 46: 657-84(27 Apr 1971).

A general analysis, developed previously (Hunt, Ludford 1968) of three-dimensional duct flows subject to a strong transverse magnetic field is used to examine the flow in diverging ducts of rectangular cross section. It is found that, with the magnetic field parallel to one pair of the sides, the essential problem is the analysis of the boundary layers on these (side) walls. Assuming that they are highly conducting and that those perpendicular to the magnetic field are nonconducting, the flow is found to have some interesting properties: if the top and bottom walls diverge, the side walls remaining parallel, then an O(1) velocity overshoot occurs in the side-wall boundary layers; but if the top and bottom walls remain parallel, the side walls diverging, these boundary layers have conventional velocity profiles. The most interesting flows occur when both pairs of walls diverge, when it is found that large, $O(M^{1/2})$, velocities occur in the side-wall boundary layers, either in the direction of the mean flow or in the reverse direction, depending on the geometry of the duct and the external electric circuit. The mathematical analysis involves the solution of a formidable integral equation which, however, does have analytic solutions for some special types of duct. (auth) (UK)

33110 SOLUTIONS IN MAGNETOHYDRODYNAMICS. Bray, Marcel. Compt. Rend., Ser. A; 272: 694-6(8 Mar 1971). (In French).

Axially symmetric solutions of a magnetohydrodynamics equation system are given. (France)

33111 FREE STREAM VELOCITY MEASUREMENTS IN A HIGH ENTHALPY SHOCK TUNNEL. McIntosh, M. K. (Australian National Univ., Canberra). Phys. Fluids; 14: No. 6, 1100-2(Jun 1971).

Two independent methods (spark tracer and magnetohydrodynamic) are described for the measurement of the velocity of the gas in the free stream of a high enthalpy shock tunnel. Comparison is made with calculated results. (auth)

33112 METHOD OF CALCULATING ISOTOPIC EFFECTS IN THE THERMODYNAMIC PROPERTIES OF SIMPLE GASES AND LIQUIDS. Malishenko, S. P.; Shval'b, V. G. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 721-7(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 762-9(Jul-Aug 1970).

It is shown that, in calculating isotopic effects in the thermodynamic properties of simple gases and liquids according to the law of corresponding states with quantum corrections, it is convenient in a number of cases to use the critical parameters of the classical isotope—a gas with the previous molecular field and an infinitely large molecular mass—instead of the parameters of the intermolecular interaction potential to reduce the thermodynamic quantities to dimensionless form. Under these conditions the properties of the classical isotope may be calculated according to the classical law of corresponding states, while the properties of the remaining isotopes may be calculated by introducing corrections to the properties of the classical isotope. This procedure is used to calculate the saturated vapor pressure and second virial coefficients of hydrogen isotopes. The isotopic effects in these properties of hydrogen may be explained completely without resorting to the hypothesis on the change in the molecular field of hydrogen due to isotopic substitution. (auth)

33113 RADIATIVE–GASDYNAMIC COUPLING AND NON-EQUILIBRIUM EFFECTS BEHIND REFLECTED SHOCK WAVES. Carlson, Leland A. (Texas A and M Univ., College Station). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 9: No. 5, 858-65 (May 1971).

Results of calculations for the flow fields behind reflected shock waves in nitrogen resulting from incident shock velocities of 8 and 11 km/sec and initial pressures of 10^{-3} and 10^{-2} cm of Hg are presented. In obtaining these results, the radiative properties of the gas were represented by an approximate nongray absorption coefficient model, and the exchange of momentum and energy due to collisions between particles was included. During the first microsecond after reflection, the radiative cooling is strong enough to cause the end-wall pressure to decrease as much as 50% before increasing to its equilibrium value. The cooling also induces a velocity acceleration towards the wall and accelerates chemical and thermal relaxation. In the region immediately behind the shock wave the electron temperature is much lower than the heavy particle temperature, but even in the near equilibrium region next to the wall the electron temperature remains about 2% below the heavy particle temperature. Comparison calculations demonstrate that two temperature effects must be included to accurately predict end-wall pressure, radiative heat transfer, and radiative-gasdynamic coupling effects. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 32993, 33002, 33038, and 33089.

33114 (LA-4536(Vol.1)) A COMPILATION OF VELA 3 SOLAR WIND OBSERVATIONS, 1965–1967. Bame, S. J.; Felthauser, H. E.; Hundhausen, A. J.; Strong, I. B.; Asbridge, J. R.; Gilbert, H. E.; Smith, D. M.; Sydoriak, S. J. (Los Alamos Scientific Lab., N. Mex.). Oct 1970. Contract W-7405-eng-36. 90p. Dep. NTIS.

Solar-wind observations performed on the Vela 3 satellites between July 1965 and mid-1967 are summarized for use in comparison with solar and geomagnetic observations. Three-hour averages of the proton density, flow speed, flow direction, and proton temperature are presented graphically for each solar rotation. These averages and the standard deviations of observations within each three-hour interval are also given in tabular form. (auth)

33115 THERMAL AND SUPRATHERMAL PLASMAS IN THE MAGNETOSPHERE. Vasyliunas, Vytenis M. (Massachusetts Inst. of Tech., Cambridge). Comments Astrophys. Space Phys.; 3: 48-52(Mar-Apr 1971).

It is concluded that if the observed keV particles form a major component of magnetospheric plasma, rather than being merely a small impurity in a vast thermal background, several problems are raised in attempting to obtain a complete understanding of the magnetospheric plasma. These problems are listed. (W.D.M.)

33116 SOLAR ECLIPSES AND THE IONOSPHERE. A NATO Advanced Studies Institute Held in Lagonissi, Greece, May 26–

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June 4, 1969. Anastassiades, Michael (ed.). New York; Plenum Publishing Corporation (1970). 319p. $18.50.

Optical and radio instruments were installed at Lagonissi, Greece to study the May 20, 1966 annular solar eclipse over North Africa and southern Europe. Data were obtained by means of satellites, riometers, a network of three ionosondes, radio-astronomical techniques, the partial-deflection technique, and direct measurements of NASA rockets. The relationship is discussed under sections entitled: theoretical aspects; D-region chemistry; solar radiation and layer theory; radio-astronomical observations; eclipse studies by rocket, satellite, and partial reflection techniques; and ionospheric eclipse effects. Observations and data from other eclipses are also included. (J.C.W.)

33117 OBSERVATION OF THE PROTON FLARE OF SEPTEMBER 2, 1966 AT THE ABASTUMAN OBSERVATORY. Khetsuriani, Ts. S.; Tskhovrebadze, A. S. Byull., Abastumanskaya Astrofiz. Observ., Akad. Nauk Gruz. SSR: No. 37: 147-50(1969). (In Russian).

A description of observational data obtained at the Abastuman Observatory for the solar-proton flare of September 2, 1966, is given. The development of the flare is described and illustrated by photographs. Curves show the behavior of different active regions with time, and the changes in solar radio-noise emission are outlined. (IAA)

33118 LA TERRA ESPLORATA E SERVITA DAI SATELLITI. Atti Ufficiali del IX Convegno Internazionale Tecnico-Scientifico Sullo Spazio, Rome, 19–21 Marzo 1969. (Earth Explored and Served by Satellites. 9th International Technical and Scientific Convention on Space, Rome, March 19–21, 1969). Roma; Rassegna Internazionale Elettronica Nucleare e Teleradiocinematografica (1969). 391p. (In several languages). (CONF-690351).

A total of 37 papers from the conference are presented. Five papers are presented in English, the remaining in several languages. The sessions are categorized according to the subject headings of geophysical studies from satellites, meteorological and natural resource studies from satellites, telecommunication studies from satellites, technical and instrumental problems, space mathematics, and general problems. (J.C.W.)

33119 AURORAL SPECTROSCOPY. Vallance Jones, A. (National Research Council of Canada, Ottawa). Space Sci. Rev.: 11: 776-826(Mar 1971).

Recent advances in the techniques of auroral spectroscopy are discussed. Present knowledge of the spectrum is reviewed including a collection of semi-empirical band intensities for the observed band systems. Variations in the spectrum in different color classes and types of aurora are reviewed, together with an account of recent developments in the theories of the excitation mechanism of auroral emissions. (auth)

33120 SOLAR ACTIVITY AS REFLECTED BY IONOSPHERIC DATA MEASURED OVER HUNGARY. Florian, Endre (Central Inst. for Atmospheric Physics, Budapest). Idojaras: 74: 400-6(Sep-Dec 1970). (In Hungarian).

Ionospheric data gathered over Budapest since 1954 were analyzed. Data were presented on the radio fluxes and solar-spot activities (10.7 cm), relationship between the densities of the ionospheric layers and solar activity, fluctuations in the boundary frequency of the E layer as a function of solar activity, and changes in the boundary frequency of the F2 layer because of solar activity There are now numerical data to substantiate the assumption that there are close relationships between solar activity and boundary frequencies (and corresponding densities) in the E and F2 layers of the ionosphere. (JPRS)

33121 BALLOON OBSERVATION OF SOLAR AND ATMOSPHERIC NEUTRONS. Kondo, Ichiro; Nagase, Fumiaki; Yasue, Hiroshi (Nagoya Univ., Japan). Tokyo Daigaku Uchu Koku Kenkyusho Hokoku: 6: 325-39(Mar 1970). (In Japanese).

Balloon observation was made on Sept. 28, 1968, at Haramachi, Fukushima prefecture, for the expected solar neutrons accompanying solar flares, according to the forecast given by the Toyokawa Observatory during the observation of solar radio bursts. An organic liquid scintillator that enables pulse-shape discrimination was used to separate the neutrons from γ rays. The solar flare of importance 2B was observed at 0149 UT, about an hour after horizontal flight began, but no increase in either neutron or γ-ray intensity was found. The upper limit of the solar neutrons from this flare was 20 neutrons cm^{-2} in the 6- to 100-MeV region. Detailed data were obtained for the intensity and the altitude variation of atmospheric neutrons, since measurement of neutrons and γ rays separately was possible in this experiment. (auth) (Japan)

33122 PROPAGATION OF VLF WAVES BELOW GENERALLY ANISOTROPIC IONOSPHERES. Abbas, M. M. (Univ. of Kentucky, Lexington); Pidwell, D. W.; Walsh, E. J. Can. J. Phys.: 49: 1040-52(15 Apr 1971).

The coupled vacuum-mode theory of Poeverlein is applied to the problem of vlf propagation in the Earth–ionosphere waveguide. The curvature effects of the Earth are included by assuming a cylindrically stratified medium. The modifications for cylindrical stratifications are introduced in the coupled vacuum-mode equations through a conformal transformation. A solution of the coupled vacuum-mode equations by numerical methods leads to the reflection coefficient matrix of the ionosphere for arbitrary directions of propagation and the magnetic field, and for arbitrary profiles of electron density and collision frequency. The reflection coefficient matrix for stratified and generally anisotropic ionosphere is employed in solving the modal equation for the Earth–ionosphere waveguide. The reflection coefficient matrix for the ground is evaluated from formulas in which curvature effects of the Earth are included approximately. The modal equation is solved by an iteration procedure, and the propagation characteristics of the Earth–ionosphere waveguide are calculated under a variety of ionospheric conditions. The variations of propagation characteristics are calculated as a function of frequency, the direction of propagation, and the dip angle of the magnetic field. A comparison of the numerical values with results of different formulations published in the literature indicates a fairly good agreement. (auth) (Canada)

33123 AURORAL COLOUR VARIATIONS. Hanna, P. B.; Anger, C. D. (Univ. of Calgary, Alberta). Planet. Space Sci.; 19: 399-411(Apr 1971).

Recently overshadowed by instrumental work, visual observation and color vision theory can nevertheless provide useful information and tests of auroral theories, at least for bright displays. Color calculations based on a normal auroral spectrum agree with its visual appearance, but Type B displays require drastic changes in red/green emission ratios around 85 km. These changes are consistent with direct electron excitation of atomic oxygen, whose relative concentration becomes negligible below 85 km. The cause of the red lower border is more likely to be N_2 1PG emissions rather than O_2^+ 1NG. The N_2 1PG intensity is at least 360 kR, corresponding to a minimum energy flux of 7×10^{13} eV $cm^{-2}sec^{-1}$ of electrons with energies above 50 keV. Particle and x-ray observations of similar very large fluxes are infrequent, consistent with the rarity of Type-B displays. Visibility of Type-A red aurora requires a minimum 6300-Å intensity of 65 kR at altitudes where quenching is not important. Blue sunlit aurora implies an N_2^+ 1NG intensity of probably 500 kR. The time constants of prominent auroral emissions account for such transient effects as colored edges in moving auroras, brief flashes of green and abrupt changes from green to red. Together with steady-state effects, these appear to explain most descriptions in the literature of auroral colors. (auth) (UK)

33124 CROSS-FIELD INSTABILITY AND IONISATION IRREGULARITIES IN THE EQUATORIAL E REGION. Prakash, S.; Gupta, S. P.; Subbaraya, B. H. (Physical Research Lab., Ahmedabad, India). Nature (London) Phys. Sci.; 230: 170-1(19 Apr 1971).

Measurements made on four Nike–Apache rockets carrying Langmuir probe and plasma-noise probe payloads, flown from Thumba in 1968, revealed the presence of irregularities in electron density with amplitudes of 5 to 20% in the scale-size range of 30 to 300 m, and 1 to 2% in the scale-size range 1 to 15 m, representing ionization irregularities. Most of the irregularities occurred in regions where the background electron density exhibited a definite type of gradient, and their positions appeared to indicate that, depending on the time of day at which observations were made, gradients of a given sign promoted generation of the irregularities, while those of the opposite sign inhibited their growth. Results from two representative flights are presented. During the evening twilight ionization irregularities were observed in regions of positive gradient, whereas at night they were present in regions of negative gradient; the irregularities occurred only in regions where the electron-density gradient and the ambient electric field were in the same direction, and under such conditions a weakly ionized plasma exhibits what is termed cross-field instability. The size of irregularity that can be produced by cross-field instability is discussed, and this mechanism may be satisfactory to explain irregularities of scale-size 30 to 300 m, but not for scale sizes of 1 to 15 m. (UK)

33125 LOSS AND REPLENISHMENT OF ELECTRONS IN INNER RADIATION ZONE DURING 1965–1967. Rosen, Alan; Sanders, N. L. (TRW Systems, Redondo Beach, Calif.). J. Geophys. Res.; 76: 110-21(1 Jan 1971).

The loss and replenishment of electrons (E > 0.3 MeV and E > 0.5 MeV) in the inner zone were studied during 1965, 1966, and

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1967 by electron spectrometers on the Pegasus A and B spacecrafts. Several features were apparent from the data: (a) The magnitude of the trapped flux and its decay time are related to the state of solar activity. (b) Large increases in flux follow large magnetic storms. The fractional increase is largest at high L values (L = 2.0) and is observable below L = 1.25. (c) The rise time of the flux increase is shortest at high L, and the decay times after storms are complex. (d) The increased flux is accompanied by a softening of the electron spectrum between 300 and 500 keV. (e) The increase in the flux of trapped electrons at L = 1.8–2.2 is accompanied by a large flux of precipitating electrons observed within the loss cone. (f) The precipitating flux decreases with decreasing L; it is also highly variable, usually ranging within one day from background to 10^6 electrons/cm^2 sec. (g) The precipitated flux e-folding energy is 41 ± 3 keV, roughly similar to the e-folding energy of the trapped flux at L = 1.8–2.2. (h) The precipitation period and maximum precipitated flux depend not only on the magnitude of magnetic activity index, Ap, but also on the length of time the activity continues. It is concluded that the exponential decay time of the inner radiation zone is a variable, dependent on the interval of time over which the decay is measured. It is suggested that the source of the precipitated electrons at L = 2 and of the increased electron flux observed at L = 1.25 is the same. The evidence for this suggestion is the similarity in behavior of the trapped and precipitated flux with magnetic activity, the similarity of the e-folding energy between the trapped and precipitated flux at L = 2, and the softening of the spectrum associated with the observed flux increases at the low L values. (auth)

33126 INTERACTION OF ENERGETIC PARTICLES WITH THE NEUTRAL SHEET IN THE TAIL OF THE MAGNETOSPHERE. Alekseev, I. I.; Kropotkin, A. P. (Moscow State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 615-19(1970).

Translated from Geomagn. Aeron.; 10: 777-83(1970).

The motion of energetic particles in the vicinity of the neutral sheet in the tail of the magnetosphere is investigated. Computations are made of the time of interaction of a particle with the sheet, which is of the nature of multiple intersections of the boundary between oppositely directed fields, and of the number of these intersections per interaction cycle. It is demonstrated that the movement of particles across the tail of the magnetosphere limits the range of possible particle energies in the tail. The limiting form of the pitch-angle distribution of particles, that nonstationary distributions must approach, is obtained. (auth)

33127 ACCELERATION OF CHARGED PARTICLES IN THE EARTH'S MAGNETOSPHERE BY AN INDUCED ELECTRIC FIELD. Romashchenko, Yu. A. (Inst. of Cosmophysical Investigations and Aeronomy, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 620-5(1970).

Translated from Geomagn. Aeron.; 10: 784-90(1970).

The mechanism of charged-particle acceleration in the magnetosphere is analyzed. Because of the presence of instabilities, the order of magnitude of conductivity along magnetic lines of force becomes the same as that across them. The particles are accelerated in the region from 1.5 R_0 to $R \gg R_0$. The flux of particles injected into the ionosphere under quiet conditions is estimated. (auth)

33128 DRIFT OF RESONANCE PROTONS IN AN ASYMMETRIC ROTATING MAGNETOSPHERE. Gurevich, A. V.; Shcherbakov, V. P. (Lebedev Inst. of Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 626-31(1970).

Translated from Geomagn. Aeron.; 10: 791-8(1970).

The drift of protons with energies E ~ 10 keV in the Earth's magnetosphere is analyzed with allowance for its asymmetry and rotation. It is demonstrated that owing to resonance between the frequency of rotation of the Earth and the frequency of the drift rotation of protons, special crescent-like orbits for protons appear around the Earth. The protons on these orbits are trapped mainly on the night side of the magnetosphere. They experience strong displacement across L shells. Owing to this, a large part of the protons with E ≈ 4 to 5 keV moves freely from the boundary of the magnetosphere, or the tail zone, or the auroral zone. (auth)

33129 DISTANCE TO THE SUBSOLAR POINT OF THE MAGNETOSPHERE BOUNDARY AS A FUNCTION OF MAGNETIC ACTIVITY. Rudneva, N. M.; Fel'dshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 635-8 (1970).

Translated from Geomagn. Aeron.; 10: 804-9(1970).

Relationships between the geocentric distances to the subsolar point of the magnetosphere boundary and the state of magnetic activity are obtained from satellite observations. It is demonstrated that the position of the auroral oval on the dayside of the Earth is associated with geocentric distance to the subsolar point. (auth)

33130 ION COMPOSITION OF THE ATMOSPHERE AT HEIGHTS OF 100 TO 200 km AND PROCESSES DETERMINING IT. Danilov, A. D. (Inst. of Applied Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 643-8(1970).

Translated from Geomagn. Aeron.; 10: 815-22(1970).

A comparison of measurements of the ion composition of the atmosphere at heights of 100 to 200 km shows that the variation of absolute ion densities with the solar-zenith angle is well defined. It is demonstrated that the photochemical theory properly explains the observed vertical and diurnal density pattern. The ion–molecule reaction of O_2^+ and N must play an important role at heights below 130 km. (auth)

33131 POSSIBLE ELECTRON TEMPERATURE ANISOTROPY IN THE LOWER IONOSPHERE. Krinberg, I. A.; Klimov, N. N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 649-52(1970).

Translated from Geomagn. Aeron.; 10: 823-6(1970).

The possible difference between the transverse and longitudinal electron temperatures in the lower ionosphere is estimated. It is shown that the difference can reach 200 to 400°K at heights of 140 to 160 km. The condition that promotes the appearance of electron temperature anisotropy is the propagation of ultraviolet solar radiation along the geomagnetic field during the daytime at middle latitudes. (auth)

33132 VARIATIONS OF THE LOSS COEFFICIENT IN THE LOWER IONOSPHERE DURING POLAR-CAP ABSORPTION. Driatskii, V. M.; Krupitskaya, T. M.; Shirochkov, A. V. (Arctic and Antarctic Scientific Research Inst., Leningrad). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 657-9(1970).

Translated from Geomagn. Aeron.; 10: 832-6(1970).

The results of computations of the diurnal variations of the loss coefficient ψ in the D region during PCA are reported. It is found that the night values of ψ substantially exceed the corresponding daytime values, particularly at heights h < 75 km. (auth)

33133 RELATIONSHIP BETWEEN DISTURBANCES IN THE LOWER IONOSPHERE AND GEOMAGNETIC Pi1 PULSATIONS, ACCORDING TO OBSERVATIONS IN ARKHANGEL'SK PROVINCE IN MARCH 1968. Ben'kova, N. P.; Bukin, G. V.; Kalisher, A. L.; Troitskaya, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow. Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 664-7(1970).

Translated from Geomagn. Aeron.; 10: 842-6(1970).

The results are reported of a comparison of occurrences of E_s layers of the polar types and the generation of irregular magnetic Pi1 pulsations based on observations in Arkhangel'sk Province in March 1968. (auth)

33134 FOUR ORIENTATIONS OF AURORAL ARCS. Lukina, L. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 668-73(1970).

Translated from Geomagn. Aeron.; 10: 847-53(1970).

The spatial and diurnal distributions of the orientations of auroral arcs at auroral-zone stations during the IQSY are examined. The auroral arcs are divided into four types according to their morphological properties, orientation, and location in space. (auth)

33135 LONGITUDINAL DRIFT OF CHORUS AND ITS RELATION TO MAGNETIC DISTURBANCES ON THE NIGHT SIDE OF THE EARTH. Kleymenova, N. G.; Raspopov, O. M.; Vigneron, J.; Nguyen Kim Thoa (Inst. of Terrestrial Physics, Moscow. Leningrad State Univ.). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 674-7(1970).

Translated from Geomagn. Aeron.; 10: 854-9(1970).

Data are presented on the relation of vlf chorus, observed at the subauroral stations Sogra and Kerguelen, to polar substorm and the development of magnetic activity on the night side of the Earth. From a comparison of chorus observations at Sogra and Norwich it is concluded that the source of chorus drifts westward. (auth)

33136 POSSIBLE EFFECT OF MAGNETOHYDRODYNAMIC DISCONTINUITIES ON THE EARTH'S MAGNETOSPHERE. Kovalevskii, I. V. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 706-8(1970).

Translated from Geomagn. Aeron.; 10: 895-7(1970).

The field of the magnetopause current at the surface of the Earth, the position of the magnetopause, and that of the bow shock (in the gas-dynamic approximation using the magnetoacoustic Mach number) are computed. The computations were based on the Pioneer-6 data on the plasma, the magnetic field, and tangential

MHD discontinuities. The possible effect of MHD discontinuities on the Earth's magnetosphere is examined. The position of the magnetopause and of the head shock wave at the subsolar point may change. The resulting deformations of magnetosphere produce both positive (SI^+) and negative geomagnetic impulses (SI^-) of up to 10 to 15 γ (at the equator). (J.C.W.)

33137 INFLUENCE OF THE LOWER LAYERS OF THE IONOSPHERE AND OF THE EARTH ON THE FIELD OF THREE-DIMENSIONAL ALFVEN WAVES. Davydov, V. M.; Snegurova, L. F. (Inst. of Geology and Geophysics, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 710-13(1970).

Translated from Geomagn. Aeron.; 10: 900-2(1970).

The fields arising under the ionosphere during the propagation of three-dimensional Alfvén waves through its lower layers have been previously computed. The spatial distribution of the amplitudes and phases of the field, their frequency dependence, and the influence on them of the Earth and of the gyrotropic ionosphere are examined. The corresponding model of the medium, taking the Earth into account in addition to the magnetosphere and ionosphere is illustrated. (J.C.W.)

33138 INFLUENCE OF ION COMPOSITION ON THE DEVELOPMENT OF THE F_1 LAYER. Koshelev, V. V.; Shchepkin, L. A.; Toporkov, V. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 713-15(1970).

Translated from Geomagn. Aeron.; 10: 903-4(1970).

The results of a selection of the optimum conditions for the development of the F1 layer at noon in summer at a latitude of ~50°N are reported. The relationship between the development of this layer and ion composition is investigated with the stipulation of fulfillment of the conditions under which the relative $[0^+]/n$ and n_0^2/n_e values obtained satisfy the known results of rocket measurements of ion composition. The computations were made for an epoch of minimum solar activity using Jacchia's model of the atmosphere and the ionization rates were computed. (J.C.W.)

33139 RELATIONSHIP BETWEEN THE F_2- AND E_s-LAYER PARAMETERS. Kolesnikova, T. V.; Starovatov, A. A.; Filonova, L. D. (Ionospheric Sector, Alma-Ata, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 715-16(1970).

Translated from Geomagn. Aeron.; 10: 905-6(1970).

The results of a correlation analysis of f_0E_s and f_0F_2 were studied to determine the possible relationship of the reaction of the sporadic-E layer to changes in the regular layer. An analysis was made of the hourly values of these parameters at Alma-Ata station in 1964. Reliable cross-correlation coefficients were obtained. Cases are sited for definite relationships between f_0E_s and f_0F_2, but negative relationships are also known. (J.C.W.)

33140 E_s FORMATION. Pozigun, V. L. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 717-18(1970).

Translated from Geomagn. Aeron.; 10: 907-8(1970).

The temporal (diurnal, seasonal, cyclic) patterns of the probability of occurrence of various types of E_s is an important aspect in theoretical computations of sporadic-layer formation. The wind-shear theory is discussed and presumes the existence of different wind directions at various heights in the atmosphere, which leads under certain conditions to the displacement of neutral ionization. Reliable data on the wind regime at heights of 90 to 150 km are from rocket data. The diurnal dependence which exists of the probability of E_s occurrence can be explained from the wind theory. The seasonal dependence of the occurrence of E_s of certain types agrees somewhat with the wind shear theory with the seasonal dependence of wind directions. However, it should be noted that the corresponding drift direction does not automatically result in E_s appearance. (J.C.W.)

33141 MAGNETIC-FIELD VARIATIONS DURING VORTICAL GAS MOTIONS FORMING AN E_s LAYER. Ignat'ev, Yu. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 719-21(1970).

Translated from Geomagn. Aeron.; 10: 909-11(1970).

The influence of vortical gas motions in the ionosphere on the formation of thin sporadic E layers is presented. This motion supports the theory of E_s formation as a result of wind shears, and the vortex model is the natural generalization of the more idealized schemes of horizontal winds with a vertical velocity gradient. The absence of a correlation between E_s and the variations of magnetic-field components has been noted. The variation of the magnetic field within an E_s formed as a result of horizontal neutral-particle winds having vertical velocity gradients has been examined. Here, an analysis is made of the magnetic-field variations to investigate a more realistic (vortex) model with allowance for diffusion. The analysis is made on theoretical data on the redistribution of charged particles caused by vortical winds in the E region. (J.C.W.)

33142 PARTICULAR CASE OF A RELATIONSHIP BETWEEN THE ELECTRON DENSITY PROFILE IN THE IONOSPHERIC D REGION AND THE FREQUENCY DEPENDENCE OF RADIO-WAVE ABSORPTION IN THE IONOSPHERE. Belikovich, V. V.; Benediktov, E. A.; Itkina, M. A. (Gorky State Univ., USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 721-2(1970).

Translated from Geomagn. Aeron.; 10: 912(1970).

In the particular case when the electron-density profile is expressed by an exponential law there is a simple relationship between N(h) and $\Gamma(\omega)$. It is a complex problem to determine the electron-density profile, N(h), in the ionospheric D region from the frequency dependence of radio-wave absorption $\Gamma(\omega)$. An application of the relationship of the profile and the absorption is examined for the PCA event of July 20, 1961, when the index was constant in a broad frequency range. (J.C.W.)

33143 CHARACTERISTICS OF THE DIURNAL VARIATIONS IN THE LATITUDINAL DISTRIBUTION OF AURORAL ABSORPTION. Gorbushina, G. N.; Zhulina, E. M. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 723-4(1970).

Translated from Geomagn. Aeron.; 10: 913-14(1970).

An analysis is made of the variation in the latitudinal distribution of auroral-absorption frequency in the course of a day. It has been demonstrated that the latitudinal distribution of auroral absorption in the Northern Hemisphere has, in addition to the main maximum at ~65°, a weakly defined secondary maximum at ~80°. Since anomalous absorption is weak in the second maximum, this maximum did not show up in the latitudinal distribution obtained because a more rigid criterion was used to select anomalous absorption events. It was found that some polar stations report a fairly high percentage of cases of anomalous absorption. An assumption was made that there is a second anomalous absorption zone. A latitudinal distribution was constructed of auroral absorption for different periods of the day in 1958. (J.C.W.)

33144 SOME PROBLEMS IN CORRECTING THE N-h PROFILE WITH ALLOWANCE FOR THE UNOBSERVED IONIZATION OF THE IONOSPHERE. Mal'tseva, O. A. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 724-7(1970).

Translated from Geomagn. Aeron.; 10: 915-17(1970).

The $h'_0(f)$ curve does not provide complete information on vertical electron distribution, especially for unobserved regions with $f_N < f_{min}$ and $f_N < f_{max}$ in the underlying layer. This entails significant errors in the computation of N(h) profile. New methods have been presented for exact computation, but few permit correcting this profile with allowance for underlying and interlayer ionization. The principles of the correction methods that were developed are presented. The method proposed of correcting the underlying ionization uses the $h'_x(f)$ curve as additional information. (J.C.W.)

33145 ANALYTICAL EXPRESSIONS FOR COEFFICIENTS OF THE CORRECTION METHOD. Mal'tseva, O. A. (Rostov State Univ., Rostov-on-Don, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 727-9(1970).

Translated from Geomagn. Aeron.; 10: 918-20(1970).

Analytical expressions for the coefficients used to correct the N(h) profile with allowance for underlying the interlayer ionizations have been presented previously. It is demonstrated that these expressions can be obtained on the basis of general principles formulated and an important property is discussed of the coefficients obtained that permits reducing the computations and separating the discrepancy for F-region frequencies in two parts, produced by underlying and interlayer ionizations. (J.C.W.)

33146 VHF EMISSION OF THE POLAR ATMOSPHERE. Gerasimov, V. I.; Zherebtsov, G. A.; Kurilov, V. A. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Novosibirsk, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 730(1970).

Translated from Geomagn. Aeron.; 10: 921(1970).

Observations at Noril'sk revealed vhf emission from a region where an aurora had appeared. A preliminary analysis of the data showed that there is a relationship between the vhf emission, auroras, radio-wave absorption, and an increase in ionization rate. Observations were made from Dec. 1, 1968 to Feb. 13, 1969, and no correlation was found between vhf emission and data from other observations. A summary is given of the patterns in the phenomena. The emission appears sporadically and is associated with geomagnetic storms and auroras. (J.C.W.)

33147 BURSTS OF λ6300- AND λ5577-A EMISSIONS IN AURORAS. Nadubovich, Yu. A. (Inst. of Cosmophysical In-

vestigations and Aeronomy, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 734-6(1970).

Translated from Geomagn. Aeron.; 10: 926-8(1970).

The records of the integral auroral light flux show brief signal bursts of one or several seconds that do not resemble the typical curves described previously and whose nature is unknown. Instruments recorded λ6300, 5577, and 4278-A emissions between January and March, 1969. On Feb. 7, 1969 it was noted that the signal bursts were accompanied by an increase in the light flux of one (λ6300 A) or both (λ6300 and 5577 A) oxygen O I emissions, whereas the nitrogen N_2^+ 4278-A emission did not intensify and, only in some cases, did it show a slight increase. The bursts probably occur in narrow height intervals. No bursts were observed during active auroras. (J.C.W.)

33148 LATITUDE AND LONGITUDE DEPENDENCE OF THE FORM OF THE DIURNAL DISTRIBUTION OF MAGNETIC ACTIVITY. Zaalishvili, I. M. (Inst. of Geophysics, Tbilisi, USSR). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 736-8(1970).

Translated from Geomagn. Aeron.; 10: 929-30(1970).

The diurnal magnetic-activity pattern depends on the season, latitude, and longitude of the observation site. The intensity and variability of the diurnal magnetic-activity pattern are also associated with solar activity. Observations during the IGY at 56 to 50° subpolar, 49 to 41° transitional, and 40 to 26° low-latitude data are used in the analyses. The average summer diurnal magnetic-activity curve at Bombay for 1923 to 1933 is shown with the aforementioned observations. (J.C.W.)

33149 POLARIZATION OF GEOMAGNETIC PULSATIONS OF THE Pi2 TYPE. Baranskii, L. N.; Vinogradov, P. A.; Raspopov, O. M. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 743-5(1970).

Translated from Geomagn. Aeron.; 10: 936-8(1970).

Polarization characteristics of geomagnetic pulsations provide information on the location of the source of pulsations and their propagation along the surface of the Earth. The polarization characteristics of Pi2 are investigated from an analysis of synchronous observations in the spring of 1968 at the middle- and low-latitude observatories in the USSR and at the magnetically conjugate points Sogra and Kerguelen. Two patterns that were revealed from the investigations are that on almost all days the number of trains with left-hand polarization exceeds that of trains with right-hand polarization, and near midnight, the major axis of the polarization ellipse is usually directed toward the northeast and after midnight toward the northwest. (J.C.W.)

33150 EFFECT OF THE WESTWARD FREQUENCY DRIFT IN INTERVALS OF PULSATIONS WITH DECREASING PERIOD. Mal'tseva, N. F.; Gul'el'mi, A. V.; Vinogradova, V. N. (Inst. of Terrestrial Physics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 745-7(1970).

Translated from Geomagn. Aeron.; 10: 939-40(1970).

The generation and propagation of hydromagnetic radiations in the magnetosphere has been studied and now attention is being paid to pulsations with decreasing period (PDP). A combination of phenomena is observed during a magnetospheric substorm that have longitudinal asymmetry, including the auroral current system, the asymmetry of the proton belt, ionospheric disturbances, and auroras. The azimuthal asymmetry of the temporal evolution of the spectrum during PDP intervals is investigated. An analysis was made of the observations of the PDP interval at Borok and Irkutsk. The pattern confirms the PDP observations. (J.C.W.)

33151 ESTIMATION OF THE INFLUENCE OF THE FINITE DIMENSIONS OF THE RING CURRENT ON THE RESULTS OF DEEP SOUNDING USING MAGNETIC STORMS. Sochel'nikov, V. V.; Koval, T. P. (All-Union Inst. of Marine Geology and Geophysics, Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 747-8(1970).

Translated from Geomagn. Aeron.; 10: 941-2(1970).

The exciting magnetic field is assumed to be homogeneous, and the source of the disturbance is the ring current flowing in the equatorial plane. From the results of deep sounding using magnetic storms, it is found that the influence of the dimensions of the ring current can be disregarded since the radius of the ring current responsible for the field of a global magnetic-storm variation exceeds that of the Earth by a factor of 3 to 4. (J.C.W.)

33152 IONOSPHERIC EFFECTS DURING THE SOLAR ECLIPSE OF MARCH 7th, 1970. Arendt, P. R. (Inst. for Exploratory Research, Fort Monmouth, N. J.). Nature (London) Phys. Sci.; 230: 89-90(22 Mar 1971).

It is thought that the supersonic movement of the Moon's shadow during a solar eclipse may generate internal gravity waves in the atmosphere and that the low wave produced may be manifest by traveling ionospheric disturbances (TIDs). TID observations were made at Fort Monmouth during the eclipse of March 7, 1970, using measurements of the integrated electron content of the atmosphere, obtained from the polarization of the beacon signal from the ATS-3 satellite at 137.35 MHz. A difficulty arises in distinguishing whether an observed TID was produced by the eclipse or induced by the magnetic storm that occurred at the time, and a relation between a TID and the eclipse could only be established indirectly. It was concluded that the observations confirmed the low-wave mechanism, and the effects of the low wave should be found right along the path of the eclipse. A velocity of the order of 300 m/sec was estimated for a wave of period of about 18 min. These findings, however, need further confirmation or more observations, preferably during other eclipses not disturbed by heavy magnetic activity. (UK)

33153 HYDROMAGNETIC DIAGNOSTICS OF PLASMA IN THE MAGNETOSPHERE. Troitskaya, V. A.; Gul'elmi, A. V. Ann. Geophys; 26: 893-902(Oct-Dec 1970).

From Symposium on comparison of the magnetospheric behavior with ground observations and new indices of geophysical activities. Include in the program of the International Association of geomagnetism and aeronomy, general assembly, Madrid, Spain, 10-11 Sep 1969.

The hydromagnetic diagnostics is used for verification of the concrete theoretical models of the pulsations. For long-period pulsations (Pc 4-5), the spectrum of one-dimensional oscillations of the magnetosphere is analyzed. Three modes are considered: toroidal and goffering modes, which represent the oscillations of magnetic shells, and the twist mode —the oscillations of the magnetic tubes in zero approximation on their curvature. Attention is drawn to the fact that the characteristics of the spectrum contain information on the plasma distribution along field lines. For pearl pulsations (Pc1), the methods and preliminary results of diagnostics of energies and fluxes of the resonance particles are described as well as of typical L parameters of the Pc1 region of generation. In the light of these results the various hypotheses about mechanisms of pearl excitation are discussed. For pulsations of increasing frequency (Pi1), the nonstationarity of Pi1 spectrum is described briefly and analyzed. The opportunity of estimation of a large-scale electric field in the magnetosphere is discussed. (auth) (France)

33154 EFFECT OF NOISE ON PROBE MEASUREMENTS IN THE MAGNETOSPHERE. Tunaley, J. K. E. (European Space Research and Tech. Centre, Noordwijk, Netherlands). Ann. Geophys.; 26: 853-61(Oct-Dec 1970).

The influence of shot noise on Langmuir probe and electric field measurements is studied for the case where the ambient plasma is very tenuous, such as in the magnetosphere. It is found that the theory of simple shot noise in the sheaths should be relevant, and this allows the magnitudes of the noise signals to be calculated. It is shown that for a probe system in the magnetosphere the shot noise, which essentially determines the threshold below which meaningful measurements cannot be made, may set nontrivial limitations to the usable bandwidth and therefore the resolution of the system, particularly when the derivatives of probe characteristics are measured directly. The minimum observable electric-field signal is estimated for the double-probe technique at low frequencies. It is shown that for magnetospheric measurements in the ulf/vlf range the use of solid rather than mesh probe is preferred for typical probe dimensions. Furthermore, the amplifiers should be located as close as possible to the probes. (auth) (France)

33155 PARTICLE PRECIPITATION AT AURORAL HEIGHTS: GROUND-BASED OBSERVATIONS. Beer, Tom (Univ. of Western Ontario, London). Contemp. Phys.; 12: 299-310(1971).

The evidence, determined from ground-based observations alone, for the existence of protons, neutrons, and electrons that are precipitated to auroral heights of around 100 km is examined. The evidence is divided into three sections: the direct observations, the ionizing effects, and the measurement of magnetic disturbances that are consequences of particle penetration. (auth) (UK)

33156 RISING WHISTLERS AT A GROUND STATION AT LOW LATITUDE. Dikshit, S. K.; Somayajulu, V. V.; Tantry, B. A. P. (Banaras Hindu Univ., India). Nature (London) Phys. Sci.; 230: 115-16(29 Mar 1971).

Rising whistlers observed for the first time at a ground station are reported; they were observed during the routine recording of whistlers at the High Altitude Research Laboratory, Gulmarg (geomagnetic latitude 24° 10′ N, geomagnetic longitude 147° 24′ E), and appeared as rising tones in the sonagrams. On the unusually quiet night of March 27, 1969, three risers were recorded in succession, preceded and followed by normal low-latitude

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whistlers, and very weak risers were also recorded on several other occasions. A new feature was that in the observed part of the frequency spectrum the time delay increased with increasing frequency. The risers were received by a 25-m vertical antenna, suitably amplified, and tape recorded. Likely explanations for these risers are put forward, including the possibility that they are caused by the vlf waves radiated from the return stroke of a lightning discharge and propagate initially in quasi-longitudinal conditions. At lower ionospheric heights the wave frequency is greater than the lower hybrid resonance frequency, and the transverse propagation from the effect of ions cannot occur for frequencies above the lower hybrid resonance frequency. As the altitude increases, however, the wave frequency becomes equal to or less than the lower hybrid resonance frequency in the region of which vlf waves propagate exactly perpendicular to the geomagnetic field lines. (UK)

33157 UNIVERSAL TIME CONTROL OF THE ANTARCTIC IONOSPHERE. Eccles, D.; King, J. W.; Challinor, R. A. (Radio and Space Research Station, Slough, Eng.). Nature (London) Phys. Sci.; 230: 198(26 Apr 1971).

A correction is offered to the communication by Challinor (NSA 23: 42083) in which it was concluded that the effects of neutral air winds on the Antarctic ionosphere may not be as important as originally suggested (J. Atmos. Terrest. Phys., 30: 11(1968)). It is also pointed out that although the 0600 UT effect is a consequence of neutral air winds, there are other features of the Antarctic ionosphere that may be associated with energetic particles, the possible effects of which have not yet been fully established. (UK)

33158 IONOSPHERIC MEASUREMENTS TAKEN WITH THE AID OF INCOHERENT SCATTERING OF RADIO WAVES BY IONOSPHERE. Misyura, V. A.; Tkatchev, G. N.; Bludov, V. Ya.; Erokhin, Yu. G. Ionos. Issled.; No. 18, 136-63(1969). (In Russian).

The incoherent-scattering method allows taking regular measurements of ionospheric parameters at 180° at distances of up to a few radii of the Earth. In addition to measuring the electron density, this method can also be applied to measuring the temperature of ions (T_i) and electrons (T_e) and ion composition. (auth)

33159 PROBING TECHNIQUE USED FOR IONOSPHERIC INVESTIGATIONS. Gdalevich, G. L. Ionos. Issled.; No. 18, 95-119(1969). (In Russian).

Probing is the main technique used for investigating the gas-discharge plasma (comparatively cold plasma with a rather low concentration and weak magnetic fields). Characteristics obtained from probing (dependences of probe current upon voltage applied to a probe) may be used for determining all the basic parameters of plasma, such as: electron and ion concentration, distribution of ions and electrons according to their energies, and plasma potential in the area of the probe. Measurements carried out by means of probing allow the local parameters of the ionospheric plasma to be determined, the results of such measurements being independent of the condition of the medium between the probing means and the Earth; thus, the technique may be utilized at any altitude. However, apart from difficulties encountered in the gas-discharge plasma, a number of difficulties that pertain particularly to the ionosphere may arise during probing measurements. (auth)

33160 RESULTS OF PERSISTENT OBSERVATIONS OF OUTER IONOSPHERE CARRIED OUT WITH THE AID OF SIGNALS COMING FROM ARTIFICIAL SATELLITES. Shmelovskii, K. Kh. Ionos. Issled.; No. 18, 84-94(1969). (In Russian).

Regular observations of the signals coming from artificial satellites are carried out at the Kulunsborn observatory. These observations yield useful information on the behavior of and changes in the outer ionosphere. A detailed description of technique used for observing the signals and processing the obtained results are given. The observed results reveal the dependence of the total number of electrons present in the ionospheric column on the solar activity help to investigate the latitude anomaly of N_e and the diurnal variations of N_e both during maximum and minimum activity. The analysis of experimental data also allows the electron temperature to be determined. It was found that in case of low solar activity, T_e is 1.5 to 2 times as high as the temperature of neutral particles, whereas in case of high activity of the Sun, T_e may come up to 3000°K. A calculation was also made of a mean rate of formation during the day time from the maximum period of solar activity to the minimum one. Similar calculations were made for the flux of ionizing radiation as well. (auth)

33161 AERONOMIC PROBLEMS OF INTERPRETING THE PROFILES OF ELECTRON CONCENTRATION IN THE F REGION. Taubenkhaim, I. Ionos. Issled.; No. 18, 59-69(1969). (In Russian).

In the F region the balance equation of the electron density, comprising ionization, electron losses, and transfer of charged particles, is mainly dependent on the balance of positive ions in atomic oxygen that are produced due to photoionization and turn into O_2^+ and NO^+ as a result of the charge exchange occurring before recombination. An explanation is given of the meaning of individual terms of this equation. Experimental laboratory and ionospheric investigations allow a quantitative estimation of the ionization and electron losses. If these data are introduced into the balance equation and compared to the profiles of the electron density found by means of ionospheric probing at middle latitudes, it seems necessary to expect considerable vertical movements of the ionospheric plasma in the F region. These vertical movements vary during the day and especially during the solar eclipse. The diffusion alone is not sufficient to explain these phenomena. (auth)

33162 AMBIPOLAR ELECTRON–ION GAS DIFFUSION AND DIFFERENTIATION OF THE F REGION OF THE IONOSPHERE. Polyakov, V. M. Ionos. Issled.; No. 18, 42-58(1969). (In Russian).

The transfer of charged particles by diffusion and drift is one of the most important physical processes occurring in ionosphere. This is especially important in the F region where the free path of charged particles and their life rapidly increase as the altitude increases. The vertical distribution of electron concentration governed by the action of a dropping diffusion flux is very similar to the Chapman's layer as far as its shape is concerned. The diffusion flux can exist owing to ionization–recombination processes. Due to the effect of the intensive sources of electron–ion gas, the level of photochemical equilibrium and zero diffusion is located lower than the maximum of the layer. In the F region of ionosphere two levels exist near which the maximum electron density may form. If these two levels are close to each other, then only the F2 layer is observed as it occurs in winter at middle latitudes. In summer, when the maximum of ion production drops down as the zenithal distance of the Sun decreases, F1 and F2 layers can be observed as separate layers. (auth)

33163 EXPERIMENTAL DATA ON DISTRIBUTION OF MAIN PARAMETERS AND VELOCITIES OF PHOTOCHEMICAL PROCESSES OCCURING IN UPPER ATMOSPHERE. Danilov, A. D. Ionos. Issled.; No. 18, 7-41(1969). (In Russian).

Main achievements in the investigation of the most important atmospheric parameters in the ionosphere with the aid of rockets and artificial satellites are surveyed. Results obtained in measuring atmospheric density are described, results of determining the composition of neutral particles by mass-spectrometric and optical methods are compared, and the main results of numerous measurements of the ion composition and electron concentration are shown. Present-day views on the ionization–recombination cycle of processes occurring in the atmosphere are expounded, and the most-reliable estimations are given of the main processes such as ionization velocity, dissociative recombination, ion–molecule reactions, and processes where negative ions are involved, emphasis being laid on the significance of the latter. It is emphasized that in the ionosphere there exists a close relationship between the processes where charged particles are involved and the neutral reactions. The problem of oxygen dissociation in the atmosphere is described, and the part the ionic reactions take in the formation of neutral components is discussed. (auth)

Low-Temperature Physics and Cryogenic Equipment

Superfluidity

Refer also to abstract 33819.

33164 EVIDENCE FOR TWO VORTEX-RING SPECIES IN DILUTE ^{4}He–^{4}He SOLUTIONS. Kuchnir, M.; Ketterson, J. B.; Roach, Pat R. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 26: 879-82(12 Apr 1971).

Measurements of the positive-ion velocity as a function of electric field in dilute solutions of ^{3}He in ^{4}He at 18 mK show a discontinuity that suggests the existence of two kinds of vortex rings in addition to the bare ion. The assignment of circulation quantum numbers is discussed. (auth)

33165 THERMALLY DRIVEN SUPERFLUID-HELIUM FILM FLOW. Liebenberg, D. H. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev. Lett.; 26: 744-7(29 Mar 1971).

Measurements of dissipation versus velocity for the flowing helium film are reported. A new probe technique allows measure-

ment of the dissipation as a temperature difference in a small region of the film. The data are interpreted in terms of the Langer–Fisher fluctuation model as modified for driven flow where $\Delta T \propto \exp[\beta\rho_s/k\rho T v_s]$. (auth)

33166 EVOLUTION OF A PULSE OF CHARGED VORTEX RINGS IN SUPERFLUID HELIUM. Gamota, George; Hasegawa, Akira; Varma, C. M. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 26: 960-3(19 Apr 1971).

Experiments with a pulsed beam of charged, quantized vortex rings show that it evolves into a steady-state distribution. This behavior is shown to follow from the Coulomb interaction among the vortices and a negative effective pressure arising from the vortex dispersion law. (auth)

33167 EXPERIMENTAL STUDY OF THE LAMBDA TRANSITION OF LIQUID HELIUM USING FIRST-SOUND ATTENUATION. Williams, Richard Dionysius. Los Angeles; Univ. of California (1970). 89p. University Microfilms Order No. 71-9261.
Thesis.

The temperature and frequency dependence of the ultrasonic attenuation of first sound in liquid helium has been measured, using a pulse-echo technique, in the ±10 millidegree neighborhood of the lambda transition. Microdegree temperature resolution is obtained by using slow temperature drifts (approximately 1×10^{-7} °K sec^{-1} near T_λ). Measurements were made at four frequencies: 600 KHz, 1 MHz, 1.75 MHz, and 3.17 MHz. The measured attenuation remains finite, is asymmetric about the transition, and exhibits a maximum on the low-temperature side. The position and magnitude of this maximum was measured in the range 16.8 to 300 KHz using a resonant technique. At a frequency ω, the maximum attenuation is shown to occur at a temperature, T, below T_λ such that $\omega\epsilon^{-1}$ = const., where $\epsilon = |T_\lambda - T|$. The absorption of sound near T_λ can be interpreted as being due to two phenomena: (1) a relaxation process described by Pokrovskii and Khalantnikov occurring only below T_λ, and having a relaxation time of $\tau = \xi/C_2$ where C_2 is the velocity of second sound and ξ is a coherence length of magnitude $1.36 \times 10^{-8} (T_\lambda - T)^{-\frac{1}{3}}$ cm; (2) a critical attenuation which is nonsingular and symmetric about T_λ due to inherent fluctuations in the order parameter. (Diss. Abstr. Int., B)

33168 ELEMENTARY EXCITATIONS, BOSE–EINSTEIN CONDENSATION, AND NEUTRON SCATTERING: A STUDY OF LIQUID ^{4}He. Tenn, Joseph Simon. Seattle; Univ. of Washington (1970). 92p. University Microfilms Order No. 71-8552.
Thesis.

Liquid helium four was studied, concentrating on what can be learned from neutron scattering at high-energy and momentum transfers. First is an account of the development of understanding of this Bose fluid, emphasizing the concept of elementary excitations and their measurement by neutron scattering experiments Analyses are made of experiments in the momentum transfer range 3 to 20 A^{-1}, and comparisons are made with the data using models that are proposed. These models, for the density–density correlation function $S(k,\omega)$, are based on the idea that in this region the neutrons essentially scatter from individual helium atoms. The models are phenomenological in nature, and their parameters are determined by application of certain sum rules that $S(k,\omega)$ is known to obey. One of these parameters is the fraction of helium atoms in the zero-momentum condensate. At very high momentum transfers (~15 A^{-1}), agreement between a simple Gaussian model and the data is found to be very good, provided the condensate fraction is taken to be finite below the lambda temperature. It is found to be 6 to 7% at T = 1.27°K, the lowest temperature where measurements have been made. The important point is that the high (k,ω) structure of the density–density correlation function is directly dependent on the condensate fraction, and the comparison of theory with experiment suggests that a small condensate is indeed present in the superfluid. In the intermediate region (k ~ 3 to 9 A^{-1}), the model is extended to take into account the collective excitations that are also excited in the liquid by neutron scattering. Other models, especially that of Fernandez and Gersch, are also considered. It is found that the oscillations in the width of the double differential cross section as a function of momentum transfer are closely related, through the sum rules, to the oscillations in the liquid structure factor S(k) about unity. (Diss. Abstr. Int. B)

33169 TWO PHENOMENOLOGICAL MODELS OF ^{4}He. Fishman, Theodore. Lafayette, Ind.; Purdue Univ. (1970). 154p. University Microfilms Order No. 71-9394.
Thesis.

The thermodynamic properties of two models of the He-4 system are explored. Specifically, the liquid and vapor phases are studied for temperatures below the critical temperature. The major thermodynamic features of the He-4 system, namely, the liquid–vapor phase transition and the λ-transition are studied as are the specific quantitative values of the first- and second-order thermodynamic functions. Thus, a rather extensive comparison is made between the thermodynamic properties of these models and the experimentally determined properties of He-4. The models, which are of interacting many Boson systems, are members of a wide class of models describable by Hamiltonians containing not only two-body interactions but also interactions among any number of the particles of the system. It is shown that there is a direct relationship between these n-body interactions and the existence of the liquid–vapor phase transition for these models. (TSS) (Diss. Abstr. Int., B)

Superconductivity

Refer also to abstracts 33434, 33476, and 33819.

33170 (CONF-700341–2) SUPERCONDUCTIVITY. Dreyfus, B. 1970. 13p. (In French). Dep. NTIS (U. S. Sales Only).
From Panel on superconductors; Paris, France (17 Mar 1970).

The different theoretical ideas on superconductivity are reviewed. The macroscopic model is reconsidered, and the penetration depth defined in terms of the London equation. Thermodynamic potentials at constant temperature and constant applied field are introduced, and hypotheses on the intermediate state, surface energy, coherence length, and vortices are considered. (France)

33171 (NP–18819) ON THE FLUCTUATION ENHANCED CONDUCTIVITY OF A SUPERCONDUCTOR: THE CORRECT EVALUATION OF THE MAKI GRAPH. Schmid, Albert (Helsinki Univ. (Finland). Research Inst. for Theoretical Physics. Karlsruhe Univ. (West Germany). Institut fuer Mathematische Physik). Jan 1971. 27p. Dep. NTIS (U. S. Sales Only).

According to Maki, a particular diagram—the Maki graph—gives a contribution to the fluctuation-enhanced conductivity of a superconductor that is infinite in the case of a thin film. It is shown that this result is spurious and that it is due to a breakdown of the standard Green function impurity technique. A new method is developed that is based strictly on the Boltzmann equation. It is shown that the temperature-dependent contribution of the Maki graph to the conductivity is negligibly small in a dirty metal. (auth) (Finland)

33172 LIMITS OF THERMODYNAMICAL STABILITY OF A SUPERCONDUCTING CYLINDER WITH INDUCED CURRENT. Arutyunyan, R. M. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 364-71(1970). (In Russian).

From the viewpoint of the quasi-phenomenological Ginzburg–Landau theory, the conditions of the thermodynamic stability of a superconducting cylinder with induced current are considered. The thickness of the cylinder walls is less than the London penetration depth. The dependence of the critical current density value on the sample dimensions is determined. (auth)

33173 MAGNETIC FLUX JUMP IN THIN SUPERCONDUCTING CYLINDERS. Arutyunyan, R. M. Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 372-80(1970). (In Russian).

On the basis of the Ginzburg–Landau equation, the magnetic flux jump in the cylindrical thin-walled samples placed in the external magnetic field is considered. It is shown that the wave function modulus of the superconductor passes through the zero value during transitions from one equilibrium state to another. (auth)

33174 FIRST-ORDER TRANSITIONS AT H_{c1} AND H_{c2} IN TYPE II SUPERCONDUCTORS. Jacobs, A. E. (Univ. of Toronto). Phys. Rev. Lett.; 26: 629-31(15 Mar 1971).

It is predicted that, for Type-II superconductors with κ values near $1/\sqrt{2}$ at temperatures below T_c, the transition at H_{c1} is first-order when $\xi_0/l \lesssim 50$ and the transition at H_{c2} is first-order when $\xi_0/l \gtrsim 50$. It may not be possible to observe the latter transition because of experimental difficulties, but the former transition should be observable. It is also shown that the vanishing of the normal–superconducting wall energy is irrelevant for determining whether a given superconductor is Type-I or Type-II. (auth)

33175 RELATIVISTIC PROPERTIES OF FLUXOIDS IN HIGH-SPEED MOTION IN SUPERCONDUCTORS NEAR ZERO TEMPERATURE. Sugahara, Masanori (Yokohama National Univ., Ohoka, Japan). Phys. Rev. Lett.; 26: 632-5(15 Mar 1971).

The uniform motion of fluxoids in a clean superconductor of extreme Type-II near zero temperature is discussed on the basis of time-dependent Ginzburg–Landau equations of the diffusion type in a high-field region ($H \simeq H_{c2}$) and of the

wave type in a low-field region ($H \ll H_{c2}$). In either case the dissipated power in the flux-flow state is found to decrease as the velocity of the fluxoids approaches $v_0 = v_F/\sqrt{3}$; in the low-field case the core energy of a fluxoid in motion assumes a relativistic expression. (auth)

33176 DENSITY OF ELECTRON STATES FOR SUPERCONDUCTOR WITH SMALL CONCENTRATION OF PARAMAGNETIC IMPURITY. Moskalenko, V. A.; Ursu, A. M. (Inst. of Applied Physics, Kishinev, USSR). Teor. Mat. Fiz.; 7: 72-8(Apr 1971). (In Russian).

Density of electron states of a superconductor with small concentration of paramagnetic impurity $1/\tau_s\Gamma \ll 1$ is investigated. The expression of the density function in the whole frequency region is obtained. This expression makes it possible to calculate thermodynamic quantities and kinetic coefficients in the form which allows the transition to the limiting case of pure superconductor or superconductor with nonmagnetic impurity. (auth)

33177 ATOMIC-BEAM OBSERVATIONS OF THE MAGNETIC FIELD OUTSIDE A TYPE-II SUPERCONDUCTOR. Brown, Truman R.; King, John G. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 26: 969-72(19 Apr 1971).

A new method is described for observing magnetic periodicities, both spatial and temporal, ultimately capable of resolving wavelengths between 100 and 10^5 Å and frequencies between 0.5 and 500 MHz. This method was used to observe the periodic magnetic field above the surface of a type-II superconductor containing a lattice of flux lines that moves under transport currents. It is believed that the measurements are the first direct observations of the flux-flow velocity in a type-II superconductor. (auth)

33178 SPECIFIC HEAT OF SUPERCONDUCTING TRANSITION METALS CONTAINING NONMAGNETIC IMPURITIES NEAR THE TRANSITION TEMPERATURE. Chow, W. S. (Univ. of Cincinnati). J. Phys., F (London); 1: 1-11(Jan 1971).

The specific heat of a two-band model for superconducting transition metals containing nonmagnetic impurities is investigated. First, the change of the thermodynamic potential of the two-band model due to the existence of interband impurity scattering is derived by making use of the Green function theory. Based on this, it is found that the specific heat of a two-band superconductor containing nonmagnetic impurities is larger than that of a corresponding pure two-band superconductor at temperatures in the immediate vicinity of the transition temperature. The difference of these two specific heats is shown to be proportional to the density of impurities, the strength of the interband impurity scattering, and the difference between the specific heat of a pure two-band superconductor with its d band in the superconducting state and its s band in the normal state and that of the same pure crystal with both its bands in the normal state. (auth) (UK)

33179 EFFECTS OF PRESSURE ON SUPERCONDUCTING PROPERTIES OF SIMPLE METALS. Coulthard, M. A. (Imperial Coll. of Science and Tech., London). J. Phys., F (London); 1: 195-201(Mar 1971).

First-principles studies of the superconducting behavior under pressure of the simple metals Al and Pb were made. Good agreement was obtained with the experimental volume derivative of the transition temperature in Al and, for higher compressions, upward deviations are predicted to occur from the linear relationship with volume observed at low pressures. In Pb, the relative rates of decrease under pressure of T_c, Δ_0, and $2\Delta_0/k_BT_c$ show the same trends as experiment, while in Al, the ratio $2\Delta_0/k_BT_c$ is found not to vary significantly with compression. (auth) (UK)

33180 SUPERCONDUCTIVITY AND LATTICE DYNAMICS OF WHITE TIN. Rowell, J. M.; McMillan, W. L.; Feldmann, W. L. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 3: 4065-73(15 Jun 1971).

The results of a tunneling investigation and the details of the electron–phonon interaction in superconducting tin are presented. From an iterative solution of the Eliashberg gap equations, the phonon spectrum, weighted by the square of the electron–phonon coupling constant, is determined. Comparison of this result with neutron scattering data suggests that, as in Pb, off-symmetry directions must be considered carefully in any determination of the tin phonon spectrum. The resolution and reproducibility of the tunneling technique is discussed at some length; in particular, it is shown that the Coulomb pseudopotential μ^* is extremely sensitive to small experimental errors. It is suggested that a value of μ^* near the theoretical value of 0.10 can be taken as an indication of acceptably accurate experimental measurements. (auth)

33181 LOW-TEMPERATURE THERMAL EXPANSION OF V_3Si. Fawcett, E. (Bell Telephone Labs., Murray Hill, N. J. Univ. of Toronto). Phys. Rev. Lett.; 26: 829-32(5 Apr 1971).

Measurements are described of the thermal expansion α of two samples of V_3Si. One shows a large anomaly in α resulting from the structural transformation, which starts above 30°K and continues below the superconducting transition temperature T_c. The other sample shows only about 1% structural transformation, and the associated anisotropy in the discontinuity of α at T_c shows that quadratic terms in the strain dependence of T_c are unusually large. (auth)

33182 STUDY OF ELECTRON SHADOW PATTERNS OF THE INTERMEDIATE STATE OF SUPERCONDUCTING LEAD. Pozzi, G.; Valdre, U. (Univ., Bologna). Phil. Mag.; 23: 745-62(Apr 1971).

Using shadow electron microscopy, observations were made of the superconducting intermediate state of hollow lead cylinders in transverse magnetic fields. The resultant structure gives rise to distorted cycloid patterns with secondary focusing spots. The images were analyzed and interpreted both qualitatively and quantitatively on the basis of a one-dimensional periodic structure (lamellar model) assuming the full expressions for the z and x components of the magnetic fields as calculated by the method described by Kittel (1946, 1949) for an infinite, flat specimen. In particular, it is shown that distortion of the cycloid patterns is produced where the width of the normal lamellae is different from that of the superconducting lamellae and that secondary spots are formed when a fine structure modulates the overall periodicity of the magnetic field distribution at the surface of the specimen. (auth) (UK)

33183 ROLE OF LOW-FREQUENCY FLUCTUATIONS IN THE JOSEPHSON EFFECT. Galkin, A. A.; Borodai, B. I.; Zilberman, L. A.; Ivanchenko, Yu. M.; Svistunov, V. M. (Physical-Techncial Inst., Moscow). Dokl. Akad. Nauk SSSR; 196: 556-8(Jan 1971). (In Russian).

The influence of low-frequency fluctuations resulting in abnormal volt–ampere characteristics and magnetic dependence of Josephson current is discussed. Superconducting tunnel contacts of the Sn/I/Sn type are studied with specific resistance $\rho_N \sim 0.01$ to 0.02 ohm, nm^2, high ratio $I_{exp}/I_{theoret} \sim 87$ to 92% and near the $\sin(\pi H/H_0)/(\pi H/H_0)$ critical current dependence on the magnetic field. For all specimens the width of the transition did not exceed the double Josephson depth of penetration ($\omega \sim 2\lambda$). (R.V.J.)

33184 LOW-TEMPERATURE STRUCTURAL INSTABILITY AND ENHANCED SUPERCONDUCTIVITY IN THE VRu ALLOY SYSTEM. Testardi, L. R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Lett.; 35A: No. 2, 117-8(17 May 1971).

Sound velocity measurements indicate a structural transformation at 55°K for the composition $(V_{0.548}Ru_{0.452})$ with near-maximum T_c in the V–Ru system. The results support the idea that superconductivity is enhanced when structural instabilities occur at low temperatures. (auth)

33185 SUPERCONDUCTIVITY IN INTERACTING CHAINS: SOME EXACT RESULTS. Mubayi, V.; Gupta, K. K. (Tata Inst. of Fundamental Research, Bombay). Phys. Status Solidi (b): 44: No. 1, 351-4(1 Mar 1971).

It is shown that for a system of interacting one-dimensional chains superconductivity cannot exist. (auth)

33186 SUPERCONDUCTIVITY OF Te AT HIGH PRESSURE. Il'ina, M. A.; Itskevich, E. S. (Inst. of High Pressure Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 1, 15-17 (5 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.: 13: No. 1, 23-6(5 Jan 1971).

Investigations were carried out in the pressure range from 40 to 100 kbar to study the superconductivity of the Te modifications that exist in this pressure interval. The measurements were made with a fixed-pressure setup. The samples were cut from a single-crystal Te block. The superconducting transition was determined from the drop of the electrical resistivity. Results on the superconductivity of the modification Te II were confirmed, and it was established that the modification Te III is also superconducting. The presence of a new modification, Te IV, occurring at ~80 kbar, was detected. (M.H.R.)

33187 RESONANCE IN SUPERCONDUCTORS. Azbel, M. Ya.; Mints, R. G. (Inst. of Theoretical Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 13: No. 2, 60-3(20 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.: 13: No. 2, 89-92(20 Jan 1971).

The influence of discrete surface states is considered on the impedance of a semi-infinite sample in an external magnetic field parallel to the surface. A formula for the resonant increment of the surface impedance is presented. (M.H.R.)

33188 COLLECTIVE EFFECT OF PARAMAGNETIC AND DIAMAGNETIC IMPURITIES ON THE SUPERCONDUCTING TRANSITION TEMPERATURE. Kirschner, I. (Roland Eoetvoes Univ., Budapest); Stark, A.; Falko, I. I. Acta Phys. Acad. Sci. Hung.: 29: No. 2-3, 243-9(1970).

The dependence of the transition temperature and its derivative with respect to pressure on the concentration of both paramagnetic and diamagnetic impurities is calculated. It is shown that the assumption of a Lifshitz singularity in the density of normal single-electronic states results in a good agreement of theoretical predictions with experimental data. (auth)

33189 INFLUENCE OF SUPERCONDUCTING TRANSITION ON INTERNAL FRICTION OF TANTALUM. Postnikov, V. S.; Zolotukhin, I. V.; Miloshenko, V. E. (Voronezh Polytechnic Inst., USSR). JETP Lett. (USSR) (Engl. Transl.); 13: No. 1, 6-9 (5 Jan 1971).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 13: No. 1, 10-13(5 Jan 1971).

The low-frequency internal friction of tantalum was studied, using thin-foil samples. The measurement of the internal friction (Q^{-1}) was based on a previously developed procedure modified by placing the samples in a helium cryostat. The sample was cantilever-mounted on a holder, and the free damped flexural oscillations produced after excitation were registered. The oscillation frequency could be 50 to 2000 Hz and the relative deformation was $E = (2 \text{ to } 3) \times 10^{-6}$. A plot of Q^{-1} obtained with a sample annealed at 1500°C for 0.5 hours in a vacuum of 2×10^{-5} Torr is shown. A sharp, high maximum was observed at the superconducting transition temperature. Available experimental data did not permit drawing an unambiguous conclusion concerning the mechanism responsible for the formation of the Q^{-1} (t) peak observed. (M.H.R.)

33190 TRANSITION TEMPERATURE OF SUPERCONDUCTING DILUTE ALLOYS. Galleani d'Agliano, E. (GNSM, Genoa, Faculte des Sciences, Orsay, France); Morandi, G. Lett. Nuovo Cim.; 1: No. 18, 729-33(1 May 1971).

Theoretical results are reported for the initial decrease of the critical temperature in superconducting alloys containing transitional impurities in the limit where, in a Hartree-Fock picture, the alloy can sustain a magnetic moment on the impurity site. (M.H.R.)

33191 FLUX-FLOW NOISE IN MAGNETICALLY COUPLED SUPERCONDUCTORS OBSERVATION OF A 1/f SPECTRUM. Wade, J. M. A. (Univ. of Oslo). Phil. Mag.; 23: No. 185, 1029-40(May 1971).

Earlier measurements of flux-flow noise spectra are discussed, and it is pointed out that this method has severe limitations as a means for studying the detailed nature of flux motion. It is also argued that the commonly used picture of flux-bundle movement is unsatisfactory from a physical point of view and should be replaced by a model in which flux motion is more coordinated and more dependent on properties of the flux-line lattice. An experiment to test this idea is described, involving the measurement of noise spectra in pairs of magnetically coupled superconducting films. The noise power spectra obtained follow a 1/f law, thus differing from spectra measured in bulk materials and so preventing any general interpretation of the results. However, it is thought that the behaviour observed is more consistent with the proposed pattern of flux motion than with the earlier flux-bundle picture. (auth) (UK)

33192 EFFECTS OF ELECTRIC AND MAGNETIC FIELDS ON THE RESISTIVE TRANSITION OF A SUPERCONDUCTOR. Klenin, Marjorie Anne. Philadelphia; Univ. of Pennsylvania (1970). 213p. University Microfilms Order No. 71-7819.

Thesis.

Studies were made to determine the behavior of the conductivity of thin aluminum films just above their superconducting transition temperature. The samples used are characterized by relatively long (of the order of the film thickness) electron mean free paths, and they consistently show transitions broader than might be attributable to the Aslamazov-Larkin conductivity alone. Data taken in the presence of parallel and perpendicular applied magnetic fields and in the presence of applied electric fields are considered. Analysis suggests that the results are consistent with a contribution in addition to the Aslamazov-Larkin term and that the two contributions may be separated in these two-dimensional systems through the study of sample behavior in the presence of some pair-breaking mechanism. (Diss. Abstr. Int., B)

33193 ULTRASONIC ATTENUATION STUDIES IN SUPERCONDUCTING LEAD. Randorff, Jack Edward. Lubbock, Tex.; Texas Tech. Univ. (1970). 68p. University Microfilms Order No. 71-9660.

Thesis.

Measurements of the attenuation of 10-, 30-, 50-, and 70-MHz longitudinal sound waves, propagated in the [100], [110], and [111] directions, were conducted on the normal and superconducting states of high-purity unstrained lead. Analysis of the data is presented in such a manner as to allow for the possibility of multiple superconducting energy gaps. The data indicate the existence of a secondary gap. The data are also compared to theoretical calculations for both weak and strong coupling models. Measurements of the ultrasonic attenuation were also conducted on a sample of strained lead for the [100] direction. Preliminary statements are made with respect to strain effects, and a simple descriptive model is proposed. (Diss. Abstr. Int., B)

33194 TEMPERATURE DEPENDENCE OF THE PEAK EFFECT IN A TYPE II SUPERCONDUCTOR. Osborne, K. E. (UMIST, Manchester, Eng.). Phil. Mag.; 23: No. 185, 1113-18 (May 1971).

The variation of critical current density with applied magnetic field strength was measured at different temperatures for a specimen that exhibits the peak effect. The results do not agree with the theory proposed by Pippard (1969). (auth) (UK)

33195 STRUCTURE AND ELECTRICAL AND SUPERCONDUCTING PROPERTIES OF NIOBIUM NITRIDE THIN FILMS. Shy, Ying Ming. Minneapolis; Univ. of Minnesota (1970). 133p. University Microfilms Order No. 70-27,189.

Thesis.

Superconducting properties of thin films of niobium nitrides were studied in relationship to the preparation techniques and the structure and composition of the films. Nitride films were prepared by dc reactive sputtering in the presence of nitrogen gas. Deposition parameters controlled included: film composition, substrate temperature, deposition rate, nitrogen partial pressure, film thickness, substrate material, and substrate bias potential. The film structure was determined by transmission electron microscopy and the qualitative film composition was monitored by use of Auger electrons. The superconducting parameters studied included the critical temperature T_c, critical current density J_c in parallel and transverse magnetic fields, the critical magnetic field H_{c2}, and the shape of the superconducting resistive transition curve. Also studied were the electrical resistivity in the normal state and the temperature dependence of the normal-state resistance. It was found that superconducting properties are sensitive to those deposition parameters that affect the content of impurities, the extent of deviations from stoichiometry and the formation of an island structure. The high electrical resistivity and the negative temperature coefficient of resistance observed in the niobium nitride thin films are mainly due to the island structure. Possible causes of island formation and methods of controlling the island structure are proposed. The confusion caused by diversive reports about the superconducting T_c's of thin-film nitrides is discussed, and a theoretical model is proposed to explain the various results. (Diss. Abstr. Int., B)

33196 SUPERCONDUCTIVITY OF CERTAIN TRANSITION-METAL ALLOYS: A SEARCH FOR SPIN FLUCTUATIONS. Riblet, Gordon Potter. Philadelphia; Univ. of Pennsylvania (1970). 118p. University Microfilms Order No. 71-7847.

Thesis.

The effect of spin fluctuations on superconductivity was studied from an essentially experimental point of view. The depression of the superconducting transition temperature by spin fluctuations for various transition-metal-alloy systems was investigated in the temperature region .030 to 1°K. Temperatures below 1°K were obtained by adiabatic demagnetization. In particular, the superconductivity of the hcp Ru-Ir, Ru-Rh, Ru-Co, Ru-Ni, Mo-Rh, and Mo-Ir and fcc Ru-Pt, Mo-Pd, Ir-Ni, Ir-Co, and Ir-Fe alloy systems was studied. It is found empirically for numerous systems that the more magnetic the impurity (Rh, Pt, Pd, Ni, Co, and Fe in that order), the more rapidly the transition temperature T_c decreases with impurity concentration. The rate of decrease of T_c with impurity concentration correlates with the rate of increase of the susceptibility and the specific heat coefficient with concentration. Theoretical arguments are presented that make an explanation for this behavior other than that of spin fluctuations unlikely. It is shown that Ir-Fe is a particularly simple system capable of quantitative confirmation of the theory of the effect of localized spin fluctuations on superconductivity. (Diss. Abstr. Int., B)

33197 SUPERCONDUCTIVITY AND MAGNETISM IN MIXED PHASES OF THE TYPE $Me_xCe_{1-x}Ru_2$ AND $Ce(Ru_{1-x}Me_x)_2$. Wilhelm, M.; Hillenbrand, B. (Siemens AG, Erlangen, Ger.). Z. Naturforsch.; 26a: 141-9(Jan 1971). (In German).

The preparation of mixed phases with the compositions

$Me_xCe_{1-x}Ru_2$(Me = Sc, Y, La, Pr, Nd, Gd, Tb, Dy, Ho, Er, Lu) and $Ce(Ru_{1-x}Me_x)_2$ (Me = Cr, Fe, Rh, Pd, Os, Ir, Pt) is described. For the La-, Pr-, Nd-, and Fe-containing alloys, a consistent series of cubic mixed crystals was found. In systems with miscibility gaps the solubility limits were determined. Cubic lattice constants, transition temperatures for superconducting T_c and spin order temperatures Θ_c are given. (tr-auth)

33198 CRITICAL MAGNETIC FIELDS OF SUPERCONDUCTING AMORPHOUS MODIFICATIONS OF BERYLLIUM AND BISMUTH. Lazarev, B. G.; Lazareva, L. S.; Semenenko, E. E.; Tutov, V. I.; Goridov, S. I. (Inst. of Physics and Tech., Kharkov). Dokl. Akad. Nauk SSSR; 196: 1063-4(11 Feb 1971). (In Russian).

Measurements made with beryllium and bismuth specimens showed that the superconducting surface of beryllium was completely destroyed at $T \rightarrow 0°K$ by 18,000 – Oe magnetic field and of bismuth by 200,000 – Oe magnetic field. The critical magnetic fields for the superconductors with maximum distorted lattice was $\geq 2 \times 10^4$ T_c and for bismuth $\geq 3 \times 10^4$ T_c. (R.V.J.)

33199 EMPIRICAL DETERMINATION OF THE ELECTRONIC SPECIFIC HEAT ENHANCEMENT FACTOR IN TRANSITION METAL ALLOY SUPERCONDUCTORS. Collings, E. W.; Ho, J. C. (Battelle Memorial Inst., Columbus, Ohio). Phys. Status Solidi (b); 43: No. 2, K123-7(1 Feb 1971).

A method is given for estimating the enhancement factor $(1 + \lambda_t)$ for a family of alloy superconductors when computing the Fermi density-of-states $n(E_F)$ from low-temperature specific-heat (γ) measurements. The method uses the approach of Morin and Maita (Phys. Rev., 129: 1115(1963)), who showed plots of ln (T_c/θ_D) vs $1/n(E_F)$ to be linear for families of transition metal alloys and compounds. The slope of ln (T_c/θ_D) vs $(0.212\ \gamma)^{-1}$ is shown to be $-1/V_{app}$, where V_{app} is the apparent pairing potential. The electronic specific heat γ_{BS} can be found from $\gamma_{BS} = \gamma/(1 + 0.212\ \gamma\ V_{app})$. (D.L.C.)

Equipment and Devices

Refer also to abstracts 32269, 33885, 33903, 33906, 33907, 33909, and 33944.

33200 (UCRL-20172) COOLING INTRINSICALLY STABLE SUPERCONDUCTING MAGNETS WITH SUPERCRITICAL HELIUM. Green, Michael A. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 4p. (CONF-710308-26). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

A supercritical helium-cooled magnet is described. This magnet, built at LRL, utilizes an intrinsically stable, low-ac-loss superconductor. The heat generated with the coil is conducted to supercritical helium cooling tubes adjacent to the magnet coil. (Several superconducting synchrotron groups have suggested this method for cooling pulsed magnets.) The experimental equipment, which differs considerably from the normal superconducting magnet system, is described. The problems associated with cooling the magnet are discussed, and the operating characteristics of the coil are presented. Some of the advantages and limitations involved with this type of magnet cooling are presented. (auth)

33201 CRYOSTAT FOR SUPERCONDUCTING SOLENOID. Vilim, F.; Gerber, R.; Roskovec, V. Cesk. Cas. Fys.; 20: No. 4, 370-2(1970). (In Czech).

A simple combined cryostat is described in which the working volume inside the superconducting solenoid is separated from the helium bath by a metal dewar. The lowest temperature is reached by overflowing of liquid helium into the working volume. After the vaporization of the liquid by means of a heater, elevated temperature can be obtained as a thermal balance between the power dissipated in the heater and heat transferred to the bath through the helium gas. The cryostat performed satisfactorily at a temperature of about 250°K in the working volume; it was designed for ballistic measurements of magnetic moments. The system of measuring coils is also described. (auth)

Plasma and Thermonuclear Physics

33202 (TID-3557(1970 Suppl.)) CONTROLLED FUSION AND PLASMA RESEARCH. A Literature Search. Whitson, Milton O. (comp.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Apr 1971. 476p. Dep. NTIS.

This search includes 2742 references on various aspects of plasma physics and controlled thermonuclear research. Report number, corporate author, and subject indexes are included. (auth)

Confinement and Heating

Refer also to abstracts 33268 and 33272.

33203 (CTO-742) EXPERIMENTS WITH A LINEAR l = 1 HIGH-β STELLARATOR ON ISAR I. Kaufmann, M.; Fuenfer, E.; Junker, J.; Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Translated by J. B. Sykes (U.K.A.E.A., Culham Lab., Abingdon, Eng.), from report IPP-1/111. 29p. Dep. NTIS (U.S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 25: 22469. (M.O.W.)

33204 (MATT-Trans-40) PLASMA CONFINEMENT IN TOROIDAL TRAPS WITH DESTRUCTED MAGNETIC SURFACES. Kadomtsev, B. B. Translated for Princeton Univ., N. J. from Zh. Eksp. Teor. Fiz.; 52: 1039-48(1967). 23p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 25108. (M.O.W.)

33205 (NYO-3958-4) A PROPOSAL TO STUDY TURBULENT HEATING OF A PLASMA. Annual Progress Report, April 1, 1970–March 31, 1971. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Contract AT(30-1)-3958. 27p. Dep. NTIS.

During the past year, research was done on scaling laws and on optimizing the experiment as a plasma heating device. The results are reported. Outstanding among these are the measurements of ion energy distribution and isotropy, and the determination that final ion temperature depends on the initial plasma conductivity. High-energy x rays were observed during the turbulent phase of heating. The measurements of energy with a multichannel analyzer and the search for an understanding of mechanisms are continuing. (M.O.W.)

33206 (ORNL-tr-2435) HIGH FREQUENCY HEATING OF PLASMA AT FREQUENCIES NEAR THE LOWER HYBRID FREQUENCY. Galaktinov, B. V.; D'yachenko, V. V.; Shcherbinin, O. N. Translated for Oak Ridge National Lab., Tenn., from report FTI-282. 8p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 11860. (M.O.W.)

33207 (UARAEE-53) COMPUTER INVESTIGATION OF THE ELECTRON TRAJECTORIES IN i) STUFFED CUSP FIELD ii) ORDINARY CUSP FIELD. Rizk, Hussain M. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1968. 40p. Dep. NTIS (U. S. Sales Only).

Analytical investigation and numerical calculations carried out with the aid of an IBM-7094 digital computer make clear the different kinds of electron trajectories in both stuffed and ordinary cusp fields, adiabatic and nonadiabatic. (auth)

33208 DIFFUSION-DRIVEN PLASMA CURRENTS AND BOOTSTRAP TOKAMAK. Bickerton, R. J.; Connor, J. W.; Taylor, J. B. (United Kingdom Atomic Energy Authority, Abingdon, Eng.). Nature (London). Phys. Sci.; 229: 110-12(25 Jan 1971).

In toroidal systems of plasma confinement the intrinsic diffusion-driven toroidal current modifies estimates of the maximum ratio of plasma pressure to magnetic field pressure. This intrinsic current may also make possible a type of Tokamak machine that operates in a steady state, unlike present pulse designs. (auth) (UK)

33209 TOROIDAL STABILIZED PINCH FORMED WITH RELATIVISTIC ELECTRONS. Hartman, Charles W. (Univ. of California, Livermore). Phys. Rev. Lett.; 26: 826-8(5 Apr 1971).

A plasma heating and confinement system based on a toroidal stabilized pinch formed with relativistic electrons is described. The pinch is formed by inducing current in a hot electron plasma confined in toroidally shaped minimum-B mirror fields. For parameters achieved with a mirror-confined hot electron plasma, current in the range 10^6 to 10^7 A carried by 10- to 100-MeV electrons is estimated to be attainable along with heating of a dense plasma background to a multi-keV temperature. (auth)

33210 ANOMALOUS DIFFUSION IN AXISYMMETRIC TOROIDAL SYSTEMS. Liu, Chuan S. (Gulf General Atomic Inc., San Diego, Calif.); Baxter, David C.; Thompson, W. B. Contracts AT(04-3)-167; AT(04-3)-34. Phys. Rev. Lett.; 26: 621-5(15 Mar 1971).

The anomalous diffusion in an axisymmetric toroidal plasma due to low-frequency instabilities is considered. The radial, cross-field diffusion is mainly due to the nonconservation of the azimuthal canonical angular momentum. In particular, the electric field component along the magnetic line of force could contribute significantly to the cross-field diffusion by driving a

change of the canonical angular momentum. For trapped particles, this diffusion could be $(B_T/B_p)^2$ larger than the $\vec{E} \times \vec{B}$ diffusion for comparable $E_{||}$ and $E_{\perp}$, where B_T and B_p are the toroidal and poloidal magnetic fields, respectively. (auth)

33211 DIFFUSION COEFFICIENTS OF PARTICLE ACCELERATION IN A TURBULENT PLASMA WITH A MAGNETIC FIELD. Kaplan, S. A.; Tsytovich, V. N.; Chikhachev, A. S. (Moscow Engineering-Physics Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: 204-16(1971). (In Russian).

Diffusion coefficients are obtained for the kinetic equation of particles interacting with different-type waves of an isotropic magnetoactive plasma. The coefficients are expressed through the spectral function of the plasma turbulence and dimensionless functions Φ_1 to Φ_7, for which the asymptotic expressions are found. The numerical results are presented as diagrams. (auth)

33212 HELICAL HELIOTRON FIELD FOR PLASMA CONFINEMENT. Uo, Koji (Kyoto Univ.). Plasma Phys.; 13: 243-55(Mar 1971).

The helical Heliotron field of the first kind is composed of a helical field, vertical field and toroidal solenoid field. The helical field is produced by a current-carrying single helical conductor which is wound around the minor axis and closes on itself after making l-circuits around the major axis. By using a computer, the helical lines of force were traced and the rotational transform, the shear, and the well depth were computed. The complex behavior of the separatrix is also clarified. In the $l = 2$ case, the helical Heliotron field of the first kind has large rotational transform and strong shear simultaneously, and also has a magnetic well. (auth) (UK)

33213 INFLUENCE OF CURVATURE OF A WALL-STABILIZED ELECTRIC ARC. Krichel, R.; Druxes, H.; Schmitz, G. (Technische Hochschule, Aachen). Z. Phys.; 244: 31-43(1971). (In German).

The analysis of gas-heating phenomena in wall-stabilized toroidal electric arcs is derived, and the results are applied to a nitrogen arc at a pressure of one atmosphere. These investigations were performed on the basis of the single-fluid model of plasma physics, taking into consideration the thermal properties of the wall material. By using a differential method it is outlined how the equation of energy is solved, not only in the arc but also in the wall. (auth)

33214 CONSTANTS OF THE MOTION FOR TOROIDAL θ AND SCREW PINCHES. Enoch, Jacob (Univ. of Kansas, Lawrence. Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 14: No. 6, 1247-57(Jun 1971).

A technique is developed for computing the constants of the motion for particles in toroidal θ and screw pinches. The technique uses classical perturbation theory with the inverse aspect ratio as the perturbation parameter. In addition, the evaluation of certain matrix elements requires the expansion of certain singular integrals in powers of the radial amplitude of the motion. The technique for carrying out expansions of this type is developed in detail. (auth)

33215 INERTIAL AND RESISTIVE EFFECTS IN TOROIDAL SYSTEMS. Greene, J. M.; Johnson, J. L.; Weimer, K. E.; Winsor, N. K. (Princeton Univ., N. J.). Phys. Fluids; 14: No. 6, 1258-67(Jun 1971).

Nearly steady-state toroidal configurations are examined analytically and numerically in a resistive, low-pressure fluid model. An optimal ordering of the physical parameters is introduced in such a way that the problem separates into two distinct time scales, diffusive and acoustic. The dispersion relation, for small oscillations on the acoustic time scale, reduces to a fifth-order algebraic equation coupling rotation, acoustic oscillations, and geodesic modes. In the supersonic regime, two oscillatory, low-frequency modes are unstable, and the rotational and geodesic modes are damped. In the subsonic regime, the rotational mode is always growing, the geodesic modes are damped, and the acoustic modes may or may not be unstable, depending on the parameters. Good agreement is found between the analytic predictions and the results of numerical simulation. (auth)

33216 HEATING OF PINCH DEVICES WITH LASERS. Vlases, George C. (Univ. of Washington, Seattle). Phys. Fluids; 14: No. 6, 1287-9(Jun 1971).

A simple thermodynamic model is used to determine the change in plasma density and temperature and in confining magnetic field strength when a θ or z pinch is subjected to strong laser heating. (auth)

Diagnostics

Refer also to abstracts 33159, 33318, 33346, and 33347.

33217 (MATT-Trans-9) NEW TECHNIQUE OF USING MILLIMETRIC AND SUBMILLIMETRIC WAVES. Bled, J.; Bresson, A.; Papoular, R.; Wegrowe, J. G. Translated for Princeton Univ., N. J., from French report. 25p. Dep. NTIS.

The extension of the microwave realm to submillimeter waves and the practical conditions of their utilization make it necessary to modify adequately the techniques and apparatus used heretofore. The methods and elements based on propagation of the TE_{01} mode in oversized rectangular guides seem to be well suited to this end. Those developed for the band between 0.5 and 5 mm are described. They are characterized by low transmission losses, great ease of setup and alignment, low cost, and very wide band. (auth)

33218 (ORNL-tr-2429) VELOCITY DISTRIBUTION OF ANISOTROPIC DEUTERIUM PLASMAS FROM TIME-RESOLVED NEUTRON SPECTRA. Neuhauser, J. (Institut fuer Plasmaphysik, G.m.b.H., Garching (West Germany)). Translated for Oak Ridge National Lab., Tenn., from report IPP-1/109. 47p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 7365. (M.O.W.)

33219 BRIGHTNESS TEMPERATURE OF A HIGH-PRESSURE ARGON PLASMA. Goldbach, Claudine; Nollez, Gerard; Peyturaux, Roger (CNRS, Paris). Compt. Rend., Ser. B; 272: 209-11 (18 Jan 1971). (In French).

A stabilized arc was studied. The aim of the experiment was to develop a high-intensity reference source operating in the visible and near ultraviolet. (auth) (France)

33220 MEASUREMENT OF THE ELECTRON TEMPERATURE OF A RAPIDLY CHANGING PLASMA. Bernard, Alain; Genta, Philippe; Jolas, Alain; Morignot, Serge (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). Compt. Rend., Ser. B; 272: 205-8(18 Jan 1971). (In French).

The electron temperature may be determined in the 10- to 40-eV range by measuring the ratio between the intensities of two adjacent lines from oxygen or fluorine ions. The method may even be applied to rapidly changing plasmas in which a quasi-equilibrium between the two ions is not attained. (auth) (France)

33221 TWO-WAVELENGTH INTERFEROMETRIC ANALYSIS OF PLASMAS PRODUCED BY FOCUSING THE BEAM OF A Nd LASER. Hugenschmidt, Manfred; Vollrath, Karl (Institut Franco-Allemand de Recherches, Saint-Louis, France). Compt. Rend., Ser. B; 272: 36-9(4 Jan 1971). (In French).

Various plasmas were studied by two-wavelength laser interferometry. The measurements made enabled quantitative results to be obtained on the electron and neutral-particle densities. (auth) (France)

33222 PAIRED COMPARISON TESTS OF THE RELATIVE SIGNAL DETECTED BY CAPACITIVE AND FLOATING LANGMUIR PROBES IN TURBULENT PLASMA FROM 0.2 TO 10 MHz. Roth, J. Reece; Krawczonek, Walter M. (Lewis Research Center, Cleveland). Rev. Sci. Instrum.; 42: 589-94(May 1971).

Paired comparison measurements of the spectrum of electrostatic potential fluctuations in a steady-state turbulent plasma confined in a magnetic mirror geometry were made with capacitive and floating Langmuir probes over the frequency range from 0.2 to 10.0 MHz. For the experimental conditions investigated ($5 \times 10^7 \leq n_e \leq 5 \times 10^8/cm^3$, $8 \leq T_e \leq 38$ eV, $350 \leq T_i \leq 930$ eV, $B_{max} = 1.0$ T), no significant difference in the relative frequency response was observed below 4.0 MHz. At about this frequency, however, the signal detected by the floating Langmuir probe dropped off relative to that of the capacitive probe. The source resistance of the turbulent fluctuations sensed by the Langmuir probe was about 400 Ω. At higher frequencies (from 7.0 to 10.0 MHz) a signal was detected by the floating Langmuir probe that was not detected by the capacitive probe. This spurious signal may be confused with the turbulent fluctuations of the plasma in the absence of paired comparison tests. (auth)

33223 METHODS FOR CALCULATING NONLINEAR ELECTRIC FIELDS IN A GAS IONIZED BY RADIATION. Rozenkrants, A. S. Elektrichestvo; No. 12: 57-61(Dec 1970). (In Russian).

Two methods are suggested for measuring nonlinear electric fields in γ-irradiated gas. The first method considered two types of charged particles and did not take into account the diffusion. The second method took into account several types of charged particles and the diffusion. The second method could be used with arbitrary geometry of the current tube and arbitrary spatial distribution of the ionization factor. It was capable of handling large magnitudes M (which could not be resolved by the other method) and determining the intensities and concentration of charged particles along the current line and also their volt–ampere characteristics. (R.V.J.)

XUM

33224 GAS PRESSURE AND ELECTRON DENSITY IN ACTIVE REGION OF HOLLOW CATHODE ARC DISCHARGES. Minoo, Habibollah (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 272: 314-17(1 Feb 1971). (In French).

The pressure variations in the active zone region (A.Z.) of a hollow-cathode arc discharge were studied as a function of the various discharge parameters. A model for the longitudinal variations in the partial pressures of the electrons (P^e), ions (P^i), and neutrals (P^0) is proposed. According to this model P^e and P^0 exhibit large variations in the A.Z. regions. Simple calculations show that in this zone: $P \approx P^c$ and $0.5 < n_e < 3.5 \times 10^{15}/cm^3$, where n_e is the electron density. (auth) (France)

33225 CONTRIBUTION TO THE THEORY OF PROBE MEASUREMENTS IN A MOVING PLASMA. Gurevich, A. V.; Smirnova, V. V. (Lebedev Inst. of Physics, Moscow. Physical-Tech. Inst., Moscow). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 639-42(1970).

Translated from Geomagn. Aeron.; 10: 810-14(1970).

The particle flux to a flat probe moving relative to a plasma is examined. The change in the flux to a plate is determined as a function of the potential and the angle between the normal to the plate and its velocity with respect to the plasma. A comparison is made with experimental data. (auth)

33226 COMPARISON OF PROBE AND SPECTROSCOPIC MEASUREMENTS IN AN ARGON PLASMA JET. Holmes, R.; Freeston, I. L. (Univ. of Sheffield, Eng.). J. Phys., D (London); 4: 452-5(Mar 1971).

The electron density of an argon plasma jet is evaluated from probe measurements using several different theoretical treatments of probe behavior in a dense plasma and the results are compared with those from spectroscopic measurements. It is concluded that none of the theories tested is adequate to evaluate the plasma density from the probe measurements. (auth) (UK)

33227 MEASUREMENT OF ELECTRON PLASMA TEMPERATURE WITH A DIFFERENTIAL CHARGED-PARTICLE ENERGY ANALYZER. II. EXPERIMENTAL RESULTS. Alinovskii, N. I.; Nesterikhin, Yu. E.; Rogozin, A. I. (Inst. of Nuclear Physics, Novosibirsk, USSR). High Temp. (USSR) (Engl. Transl.): 8: 556-9(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.: 8: 596-600(May-Jun 1970).

The electron temperature T_e of a plasma produced by a conical induction source was measured to demonstrate that the measurement method gives correct results. The maximum values of T_e were of the order of 150 to 250 eV. A slight preionization in the plasma source caused no noticeable increase in the electron temperature, merely increasing the density and total number of charged particles in the plasma. (auth)

33228 POSSIBILITY OF DETERMINING THE ENERGY OF A BEAM OF SLOW ELECTRONS BY A SPECTROSCOPIC METHOD. Busygin, E. P.; Grigoryants, V. G.; Zhukov, B. G.; Yavor, I. P. (Ioffe Inst. of Physics and Tech., Leningrad). High Temp. (USSR) (Engl. Transl.); 8: 615-17(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 657-9(May-Jun 1970).

A spectroscopic method for determining the energy of a monoenergetic electron beam that excites a rarefied gas is described. Measurement of the absolute intensity of a line or of the relative intensity of two lines and the excitation functions enables the determination to be made. Conditions for the validity of the method are listed, and an example of such a determination is given for the near-anode region of a cesium diode operating in an unprecompensated prediscarge Knudsen mode. De-excitation of levels by electron collisions was found to be negligible, and the energy distribution found was very narrow, going from 3.5 to 4.5 eV. (D.L.C.)

33229 ANALYSIS OF THE EFFECT OF THE SELF-REVERSAL OF SPECTRAL LINES ON THE MEASUREMENT OF PLASMA (OR FLAME) TEMPERATURE. Licki, J.; Suckewer, S. (Inst. of Nuclear Studies, Swierk, Poland). High Temp. (USSR) (Engl. Transl.) 8: 472-7(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 500-7(May-Jun 1970).

The calculated shapes of the spectral lines used for measuring plasma temperatures and densities are presented. The calculations are carried out for two assumed temperature profiles in the boundary layer of the plasma flow in an MHD channel for various optical thickness of the core of the flow and the boundary (wall) layer. The resultant contours are used in order to analyze the errors in measuring temperatures by the methods respectively based on recording absolute intensities and the reversal of the spectral lines. (auth)

33230 MICROWAVE PROBING OF PLASMAS INCLUDING ELECTRON COLLISION INTERACTIONS. Fogelson, Stephan A.; Grimwood, Paul R. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids; 14: No. 6, 1183-6(Jun 1971).

Slightly ionized plasmas with a Maxwellian electron velocity distribution and non-Maxwellian electron–neutral molecule interaction are treated by using a modified Langevin equation having a complex dissipative factor g in the manner proposed by Molmud. At frequencies near the average electron collision frequency, this factor is evaluated and plotted for two plasma types in which the electron–neutral molecule interaction is non-Maxwellian. The interactions approximate that between an electron and an air or nitrogen molecule, and that between an electron and a helium molecule. The results are used to compute the microwave power transmission coefficient and transmission phase shift, assuming a plane wave–uniform plasma slab geometry, for weakly ionized plasmas with the above interactions, at frequencies near the average electron collision frequency. Composite parametric plots are developed from the computations which provide a convenient means for obtaining the plasma electron number density and average electron collision frequency from experimentally measured values of the power transmission coefficient and transmission phase shift. (auth)

33231 ELECTROSTATIC PROBE MEASUREMENTS IN A COLLISIONLESS PLASMA SHEATH. Yamada, Hideo; Murphree, David L. (Mississippi State Univ., State College). Phys. Fluids; 14: No. 6, 1120-6(Jun 1971).

Experimental data are presented on electrostatic probe measurements in the collisionless plasma sheath of a 3.2-cm-diam conducting plate. The plate was immersed in a glow discharge-produced argon plasma in which the pressure was varied from 0.2 to 0.8 μ. A movable probe of 0.0064 cm diam, 0.64 cm length, tungsten wire was used as a Langmuir probe, emissive probe, and floating emissive probe. The data explicitly shows that experimental measurements to determine the local sheath potential based on Langmuir probe theory are meaningless. However, it is explicitly shown that the experimentally measured floating potential distributions of the emissive probe and the floating emissive probe in the sheath of a positive plate do follow the expected trend of the local potential of the plasma sheath. (auth)

33232 CONTINUUM THEORY OF SLENDER ELECTROSTATIC PROBES. Whitman, Alan M.; Chien, Chung-jen (Univ. of Pennsylvania, Philadelphia). Phys. Fluids; 14: No. 6, 1115-19(Jun 1971).

The continuum theory of electrostatic probes is developed for axisymmetric probes of arbitrary shape under the restriction that their maximum diameter is much smaller than their length. The current–voltage characteristic is not computed explicitly, but it is shown that the saturation currents drawn by this class of probes as well as the current drawn by them at the plasma potential are all proportional to each other. This proportionality constant, a function of the probe shape, is calculated for a cylindrical probe which has spheroidal ends. (auth)

33233 LIGHT-SCATTERING SPECTRA CALCULATED ON AN ELECTRONIC COMPUTER FOR A PLASMA HAVING VARIOUS PARAMETERS. Pyatnitskii, L. N.; Olevinskii, K. K. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 846-9(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 901-5(Jul-Aug 1970).

Results are given of computer calculations of the function Γ that determines the cross section of light scattering by plasma and functions that allow calculation of the plasma parameters from the characteristics of the experimental spectra without resort to measurements of the absolute intensity of the scattered light. The results obtained previously (Phys. Rev., 120: 1528(1960)) are used as the basis for the calculations. (auth)

33234 USE OF A SMALL PROBE FOR DETERMINING THE TEMPERATURE AND TOTAL PRESSURE PROFILES IN A DENSE PLASMA FLOW. Petrov, M. D.; Sepp, V. A. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 814-18(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 868-74(Jul-Aug 1970).

Results of a method for measuring the enthalpy, temperature, and total pressure by a calorimetric probe on a device with an electric-arc air heater are presented. The measurement errors are evaluated. The total pressure and enthalpy profiles are determined in an open stream and in various channels at a maximum temperature of 5000°K on the axis of the flow, velocity to 900 m/sec, and pressure of 10^5 N/m^2. (auth)

33235 CALCULATION OF PLASMA CONDUCTIVITY. Rogov, V. S. (Applied Mathematics Inst., Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 653-8(Jul-Aug 1970).
Translated from Teplofiz. Vys. Temp.; 8: No. 4, 689-94(Jul-Aug 1970).

Simple formulas are derived for the electrical and thermal conductivities of plasma considered as a multicomponent mixture by using the fourth Chapman–Enskog approximation. The calculations are performed for a completely ionized plasma, using Debye-potential quantum-mechanical diffusion cross sections. The Debye potential is computed in the Born approximation. Results are given for the electrical conductivity of argon and xenon. (auth)

33236 TEMPERATURE PROFILE OF THE PLASMA COLUMN OF AN INDUCTION DISCHARGE IN ARGON AT ATMOSPHERIC PRESSURE. Trekhov, E. S.; Fomenko, A. F.; Khoshev, Yu. M. (Moscow Engineering-Physics Inst.). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 685-93(Jul-Aug 1970).
Translated from Teplofiz. Vys. Temp.; 8: No. 4, 721-30(Jul-Aug 1970).

Spectral measurements were carried out, and it is concluded that local thermal equilibrium is present in the near-axial zone of an induction discharge in argon at atmospheric pressure. The distributions of the electromagnetic fields and the integrated parameters of the discharge—the power input and the inserted resistance—were obtained from the experimental radial-temperature profiles. A comparison was made between the experimental results and the calculations of various authors. The discrepancy between theory and experiment in the temperature distribution in the near-axial zone of the discharge is discussed. (auth)

33237 INVESTIGATION OF THE SPACE AND TIME CHARACTERISTICS OF THE PLASMA BEYOND THE NOZZLE OF A PULSED ELECTROMAGNETIC ACCELERATOR. Ivanova, L. E. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 694-7(Jul-Aug 1970).
Translated from Teplofiz. Vys. Temp.; 8: No. 4, 731-5(Jul-Aug 1970).

Experimental results are given of spectroscopic investigations of the plasma of a pulsed coaxial accelerator of the erosion-type for an initial pressure 5×10^{-5} mm Hg in the vacuum chamber. The time distribution of the concentration and the electron temperature were investigated at a series of points along the accelerator axis beyond the nozzle. The radial electron temperature distribution was obtained. (auth)

33238 HIGH-CURRENT PULSE DISCHARGE IN LITHIUM. Klementov, A. D.; Mikhailov, G. V.; Nikolaev, F. A.; Rozanov, V. B.; Sviridenko, Yu. P. (Lebedev Inst. of Physics, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 698-702(Jul-Aug 1970).
Translated from Teplofiz. Vys. Temp.; 8: No. 4, 736-40(Jul-Aug 1970).

The dynamics of the processes underlying the development, structure, and radiation of a high current pulsed discharge in a dense lithium plasma were studied. The discharge pinch was bent and twisted, expanding at a velocity of ~1.3 km/sec; its structure was nonuniform. The temperature of the discharge was 25,000 to 30,000°K. The radiation was of a recombination nature. The plasma of the discharge was transparent to the ultraviolet part of the spectrum, but became optically dense (opaque) on passing to the visible region. The energy introduced into the discharge (17.5 kJ) was completely carried away by radiation. (auth)

33239 DIAGNOSTICS OF THE DYNAMICS OF A DISC DENSE PLASMA FOCUS DEVICE. LaMuth, Henry Lewis. Columbus, Ohio; Ohio State Univ. (1970). 163p. University Microfilms Order No. 71-7499.
Thesis.

Three disc-shaped plasma focus devices, exhibiting axial and mirror geometry, were constructed from three-inch-long pyrex cylinders of three different inside diameters: 21, 12, and 8.25 inches. The electrodes were dish shaped and copper, with 50% transparency, giving 1.25 inch central gap. Three 15-μF capacitors, positioned symmetrically about the devices, were discharged at 20 kV. The 8.25-inch device yielded the best focus. The imploding shock had a velocity of 4×10^6 cm/sec at .7 torr deuterium, the best working pressure. The focus was found to have a minimum volume of about 3 cm^3, a duration of .2 to .3 μsec, electron densities of $10^{19}/cm^3$, deuteron densities of $10^{19}/cm^3$, and estimated copper impurity densities of $10^{17}/cm^3$. The focus exhibited both the "sausage," or m = 0, instability and the "kink," or m = 1, instability; the maximum current and voltage across the device at focus were 450 kA and 10 kV, respectively. The lack of measurable x rays and neutrons, along with relaxation time analysis, yielded upper limits of 130 and 200 eV for the electron and deuteron temperatures, respectively. (Diss. Abstr. Int., B)

33240 EFFECT OF GAS PRESSURE ON THE DETECTING PROPERTIES OF PLASMA. Sobol, G. A.; Sobol, A. G. (Lvov Polytechnic Inst.). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 13: No. 10, 1589-90(1970). (In Russian).

The dependence of the detected current on the gas pressure in a discharge tube was investigated by means of a double probe. The derived formula indicated that there is a complex relationship between the current and the gas pressure: as the pressure increases, the current first increases, then reaches a maximum and decreases. The parameters may be determined by keeping constant the potential difference between the probes and the field gradient in the plasma near the probes. The measurements were carried out with a system which contained, in addition to the dc source, an induced high-frequency signal in the probe circuit. The gas pressure was varied by the addition of gas to the system or changing the temperature of the liquid mercury drop. Good agreement was found between experimental data and calculated values, except for pressures of P < 2 mm of Hg. At such pressures, the influence of the Ramsauer effect could be felt. Neon, argon and mercury plasmas were investigated. (TTT)

33241 CAVITY MODES FOR DETERMINATION OF PLASMA ELECTRON DISTRIBUTION. Sen, S. K.; Mukhopadhyay, S. (Univ. of Calcutta). Int. J. Electron.; 30: No. 5, 491-500(May 1971).

A theoretical investigation was made on the choice of various TM and TE cavity modes and their combinations in the perturbation method of determination of radial electron density distribution in a plasma column. The modes at S and X bands were chosen from consideration of electric field configuration, cavity design, calculated frequency shifts for different axial electron densities, and the ratios of such shifts corresponding to a pair of modes for rectangular, killian, parabolic, and trapezoidal types of distribution. Further, it was suggested that the additional cavity modes may provide more data for electron density distribution by the perturbation methods due to Hess (1964) and Burkley and Sexton (1968). (auth) (UK)

33242 APPARATUS FOR THE SPACE- AND TIME-RESOLVED MEASUREMENT OF ELECTRON TEMPERATURE AND DENSITY IN A PLASMA BY THOMSON SCATTERING OF LASER LIGHT. Segre, S. E.; Martone, M. (Laboratori Gas Ionizzati, Frascati, Italy). Nuovo Cim.; 3B: No. 1, 45-54(11 May 1971).

An apparatus is described for the measurement of electron temperature and density by means of Thomson scattering of laser light. (auth)

33243 DIAGNOSTICS OF TP-D PLASMA BY CO_2 LASER. 3. Nakatsuka, Masahiro (Osaka Univ.); Yokoyama, Masahiro; Yamanaka, Chiyoe; Izawa, Yasukazu; Toyoda, Koichi. Kakuyugo Kenkyu; 26: No. 2, 72-81(Mar 1971). (In Japanese).

In the present experiment, measurements were made of forward scattering ($\theta = 10°$) from a TP–D plasma by CO_2 laser radiation. It was found that the refraction effect of the laser beam by the plasma becomes important at small-angle forward scattering. Electron densities measured by interferometry, scattering, and refraction as a function of discharge current shows fairly good agreement. (auth) (Japan)

Kinetics (General)

33244 (PTB-JB-1/71) BROADENING OF THE SPECTRAL LINES OF LIGHT- AND MEDIUM-WEIGHT ELEMENTS IN ARC PLASMA. Wende, B. (Physikalisch-Technische Bundesanstalt, Brunswick (West Germany)). [1968]. 125p. (In German). Dep. NTIS (U. S. Sales Only).

An experimental testing of the line-broadening theory for neutral atoms of light and medium-heavy elements (H, C, N, O, Ne, Ar) was made. The experimental results were compared with the collision attenuation theory and the new calculations of Griem et al. The theories are discussed and evaluated for the comparison of the experimental and theoretical results. The Stark-effect constants were calculated from the measured line profiles produced by the Stark effect and compared with Stark-effect constants measured in static electric fields. From the degree of agreement of both methods of determining the Stark effect, constants can be evaluated regardless of whether the theoretical expressions are valid and whether the microfields of electrons and ions in plasma were evaluated correctly. Several suitable lines of each element were selected whose line-

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broadening parameters and Stark-effect constants make them useful for plasma diagnostics. (tr-auth)

33245 (RFP-Trans-68) HOLLOW-CATHODE DISCHARGE WITH CONCENTRIC SPHERICAL ELECTRODES. Waechter, F.; Hutanu, G. Translated from Phys. Lett.; 28A: 370(1969). 3p. Dep. NTIS.

The discharge tube was built in three different configurations and has four electrodes. The spherical electrode in the center is surrounded by two cups made of aluminum, which are separated from each other by a ring-shaped electrode. This forms the second spherical surface. Diagrams of the volt–ampere characteristics of the device are given. (M.O.W.)

33246 PROBLEMS OF USING VOLUME SOURCES IN PLASMA SPECTROSCOPY. Borodin, V. S.; Golubovskii, Yu. B. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 49-54(Aug 1970). (In Russian).

Some problems of the application of volume light sources in spectroscopy were studied, various ways of illumination of the spectral instruments being considered. (auth)

33247 INFLUENCE OF A MAGNETIC FIELD ON THE TRAJECTORY OF IONS IN A PENNING DISCHARGE GAP. Ivanova, T. I.; Pustovalov, G. E. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; 11: 501-6(Sep-Oct 1970). (In Russian).

Calculations were made using a dimensionless magnitude H which determines the influence of magnetic fields on the ions in a Penning discharge tube and depends on the magnetic field intensity, anode potential, the type of gas, and the cell geometry. A computer was used for calculating ion trajectories for various tubes, initial ion coordinates, and H magnitudes. It is shown that the magnetic field influence becomes considerable at H > 0.1. (tr-auth)

33248 THEORETICAL ANALYSIS OF A PULSED PLASMA ACCELERATOR. Hrynczuk, J. (Inst. of Fluid-Flow Machines, Danzig). Pr. Inst. Masz. Przeply.; No. 37, 65-9(1967). (In Polish).

The mathematical description of the motion of a plasma column in a pulsed accelerator is given. The results obtained with the present approach show better agreement with experiments than the results of earlier theories based on the model of a "rigid rod" moving under the influence of electrodynamic forces. (auth) (NSA of Poland)

33249 HIGHLY TIME RESOLVED STUDIES OF TRANSIENT ELECTRICAL DISCHARGES. Haydon, S. C. (Univ. of New England, New South Wales). Elec. Eng. (Sydney); 47: No. 10, 28-31(Oct 1970).

A summary is given of the development of techniques for studying gas discharges at the New England University (N.S.W.). A brief description and illustrations are given of discharge-initiating techniques: overvoltage application from a coaxial cable of 50 Ω impedance into a matched cable; and firing of a thyratron 100 nsec before electron release from the discharge cathode of a charged condenser. Time-resolving techniques using high-speed shutter photography are outlined, and some observations using the method are illustrated for hydrogen ionization. High-power uv laser development with nitrogen is briefly discussed. (Australia)

33250 HARD X-RAY SPECTRUM OF A PLASMA FOCUS. Lee, J. H.; Loebbaka, D. S.; Roos, C. E. (Vanderbilt Univ., Nashville). Plasma Phys.; 13: 347-9(Apr 1971).

The spectrum of hard x rays from the plasma focus determined by using electron sensitive nuclear emulsions is reported and compared with the predictions of the proposed models; preliminary data on neutron anisotropy is also presented. (auth) (UK)

33251 THERMAL SHOCK WAVES IN PLASMA. Zolotovskii, O. A.; Koroteev, V. I.; Kurtmullaev, R. Kh.; Semenov, V. N. (Inst. of Nuclear Physics, Novosibirsk, USSR). Dokl. Akad. Nauk SSSR; 197: 564-7(21 Mar 1971). (In Russian).

Previous experiments with collisionless plasma revealed that the heat conserved by the plasma electron component may be transferred, along the magnetic field, at a rate considerably slower than thermal. Moreover, the perturbation itself is similar to shock waves. An attempt was made to examine in detail the observed phenomena. Curves of magnetic field variations and the rate of propagation recorded by magnetic probes were constructed and analyzed. Data obtained showed that, under certain conditions during the dispersion of the cloud of hot electrons along the magnetic field, a steady motion of the shock-wave type appeared. In such a wave the plasma medium as a whole remained static, while the heat was transferred only by its insignificantly small part consisting of hot electrons. (R.V.J.)

33252 FEATURES OF A QUASI-ELECTROSTATIC FIELD OF SOURCES IN A MAGNETOACTIVE PLASMA. Chugunov, Yu. V. Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 44-53(1971). (In Russian).

Taking the thermal motion of charged particles in the medium into account, the features contained in the solution of the equation for the quasi-electrostatic field of the sources in the magnetoactive plasma are considered. The region where the spatial dispersion may be neglected is determined. The shot losses associated with collisionless attenuation of the quasi-electrostatic field are calculated for the cylindrical probe model. In some cases these losses are shown to be the main contribution to the value of the real part of the impedance at the frequencies where the plasma resonance is absent. (auth)

33253 HIGH-POWER CONSTRICTED PLASMA DISCHARGE COLUMN. II. EXPERIMENTAL INVESTIGATION. Wheeler, C. B. (Imperial Coll. of Science and Tech., London). J. Phys., D (London); 4: 400-7(Mar 1971).

Measurements are made of the electrical parameters of high-current discharges in capillaries and the results compared with a recent theory put forward by Wheeler (1970). There is excellent agreement between the experimental electrical characteristic and the theoretical prediction which has the form $E \propto I^{\frac{1}{3}}$. The capillary voltage drop is found to depend on the nature of the initial gas filling. This is unexpected and leads to a thorough investigation of the process and consequence of wall evaporation. It is shown that the discharge plasma is almost exclusively composed of ionized wall material with an average ionic charge of the order of 3. However, it is suggested that the initial phase of the discharge, which is controlled by the gas filling, influences the subsequent rate of evaporation of wall material. (auth) (UK)

33254 CAPACITANCE AND THICKNESS OF SPACE-CHARGE SHEATHS AT PLASMA-WALL BOUNDARY. Chiplonkar, V. T.; Desai, Y. R. (Inst. of Science, Bombay). Curr. Sci. (India); 40: No. 10, 261-2(20 May 1971).

Dynamic response of the spacecharge sheath at a plasma-wall boundary is theoretically discussed, considering the nonuniform electric field in the sheath and its effective nonlinear resistance. A pulse method for obtaining the equivalent sheath capacitance and resistance is suggested. (auth)

33255 NUMERICAL STUDY OF THE MAGNETIC SHOCK TUBE. Schneider, S. H.; Chu, C. K.; Leonard, B. P. (Columbia Univ., New York). Phys. Fluids; 14: No. 6, 1103-8(Jun 1971).

Unsteady, one-dimensional magnetohydrodynamic shock formation in a shock tube was studied by numerical solution of the single-fluid continuum equations, using numerical dissipation as the only diffusion mechanism. The results are qualitative inasmuch as the exact shapes of the various profiles are not predicted. However, considerable physical insight was gained, particularly concerning the early-time evolution of the shock wave and its separation from the drive-current layer. By appropriate scaling, these results can be compared with experiments, and are useful in their interpretation. Many of the departures of experimental results from ideal theory can be explained in terms of finite dissipation, without introducing anomalous effects. (auth)

33256 PROPAGATION OF COHERENT RADIATION IN A CYLINDRICAL PLASMA COLUMN. Steinhauer, Loren C.; Ahlstrom, Harlow G. (Univ. of Washington, Seattle). Phys. Fluids; 14: No. 6, 1109-14(Jun 1971).

Refraction plays a very significant role in the absorption of laser energy in high-temperature plasmas. The geometry considered here is a long cylindrical magnetically confined plasma. The laser pulse is assumed to enter the plasma from the ends. It is then necessary that the radiation propagate the full length of the plasma so that it will be absorbed. The refraction of the laser radiation in the plasma column depends on the radial distribution of the density. Several representative density profiles are considered and solutions for the propagation are presented. It is shown that a profile with the maximum density on the axis is very difficult to heat over long distances; but, if the density has a minimum on the axis, then plasma column acts like a "light pipe" and traps the laser beam. In this case the effective absorption length of the laser beam is also reduced. (auth)

Kinetics (Experimental)

33257 TIME-RESOLVED LIGHT-SCATTERING MEASUREMENTS OF THE SPECTRUM OF TURBULENCE WITHIN A HIGH-β COLLISIONLESS SHOCK WAVE. Keilhacker, M.; Steuer, K.-H. (Max-Planck-Institut fuer Plasmaphysik, Garching, Ger.). Phys. Rev. Lett.; 26: 694-7(22 Mar 1971).

Strong current-driven turbulence is observed in high-β collisionless shock waves under $T_e \sim T_i$ and $v_d \ll v_e$ conditions. The level and the frequency and wave-number spectra of this turbulence are

measured by scattering light from the shock. The turbulence is probably due to an electron-cyclotron drift instability. (auth)

33258 RADIATION LOSSES OF A THETA-PINCH PLASMA IN THE WAVELENGTH RANGE 10 TO 200 A. Engelhardt, Wolfgang (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 244: 70-85(1971).

In order to measure the radiation losses of a theta-pinch plasma (electron density n_e = 1 to 5 × 10^{16} cm^{-3}, electron temperature T_e = 150 to 350 eV), a grazing-incidence spectrograph is absolutely calibrated in the range 10 to 200 Å. This is done in two steps: First, the measured intensity ratios of lines emitted by hydrogen-like ions are compared with their calculated values thus yielding the relative sensitivity of the instrument. The result is confirmed by incorporating well known intensity ratios of lithium-like ions. Second, absolute calibration is possible by hanging the spectrograph on an absolutely calibrated monochromator via the branching-ratios of lithium-like ions. Radiation losses from the plasma turn out to be negligible as compared with heat conduction losses and the total energy radiated is found to be small compared with the energy content of the electrons, if the impurity concentration does not exceed 0.5%. The radiation is found to be predominantly emitted by the resonance lines of the oxygen and carbon ions O VI, O VII, O VIII, CV, and CVI, whereas continuum radiation and the contribution from other ions are negligibly small. However, in discharge where the oxygen concentration reaches 5%, radiation losses can exceed the losses by heat conduction during the early phase of the discharge. But still the final electron temperature is not significantly influenced by the impurities. (auth)

33259 PARTICLE TRAPPING BY A WAVE OF LARGE AMPLITUDE. Guillemot, Michel; Matthieussent, Gilles; Olivain, Jack; Perceval, Francoise; Quemeneur, Agnes (EURATOM–CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser B; 272: 579-82(8 Mar 1971). (In French).

The deformation of the electron distribution function of a plasma subjected to an electron plasma wave of large amplitude was studied experimentally. The spatial spreading of the potential associated with this wave is shown. In the case studied, the appearance of amplitude oscillations in the wave corresponds to the formation of a plateau in the distribution function in the region of the phase velocity. (auth) (France)

33260 USE OF RADIOACTIVE TEST IONS IN THE MEASUREMENT OF THE SPATIAL DISTRIBUTION OF PLASMA ION DRIFT SPEEDS. Dreicer, Harry; Henderson, Dale B.; Mosher, David (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids; 14: No. 6, 1289-92(Jun 1971).

Radioactive test ions were used to measure the axial ion drift speed distribution in a single-ended Q machine. In the main plasma region these drift speeds are found to be significantly smaller than predicted by the sheath model. (auth)

33261 OBSERVATIONS OF ANOMALOUS PLASMA TRANSPORT PRODUCED BY MAGNETIC FIELD ERRORS. Jernigan, T.; Prater, R.; Meade, D. M. (Univ. of Wisconsin, Madison). Phys. Fluids; 14: No. 6, 1235-40(Jun 1971).

The plasma transport to the internal ring of a multipole-like device was increased by over an order of magnitude by the addition of a 1% magnetic field error which causes field lines to spiral across the confinement region. Magnetic field perturbations which keep the field lines closed produce a negligible increase in plasma loss to the internal ring. The plasma is observed to flow radially toward the loop at the region of the perturbation and then E × B drifts azimuthally affecting the density profile everywhere in the device. The increased loss under the influence of a 1% perturbation corresponds to an effective diffusion coefficient that is ≈20% of the Bohm value. Detailed experimental studies of the plasma transport and azimuthal density profiles are in qualitative agreement with a model which considers diffusion of plasma along the perturbed magnetic field to the internal ring. (auth)

33262 ONSET OF ANOMALOUS PLASMA RESISTIVITY AFTER APPLICATION OF A STEP ELECTRIC FIELD. Robin, James E.; MacKenzie, K. R. (Univ. of California, Los Angeles). Phys. Fluids; 14: No. 6, 1171-6(Jun 1971).

A photoionized argon plasma was subjected to a step E field of the order of 10^{-2} V/cm ($1 < E/E_r < 80$, where E_r is the runaway field). In a magnetic field-free plasma the electron current rose linearly to a maximum value (the time of which varies as $E^{-\frac{1}{2}}$) and then fell as the result of the rapid growth (in a few wave periods) of ion wave turbulence (consisting almost entirely of waves traveling at large angles to the E field). In the presence of a magnetic field parallel to E (zero to 150 G) the time of the current maximum decreased by 40% to a minimum at 40 G (presumably due to finite geometry effects) and then rose almost linearly from this point by a factor of 2 at 150 G. Wave propagation was still at large angles to E. Parameters were $4 \times 10^8 < n < 4 \times 10^9$ ions/cm^3; $kT_e \simeq 0.36$ eV; $kT_i \simeq 0.025$ eV. (auth)

Kinetics (Theoretical)

Refer also to abstracts 33389 and 33492.

33263 (LRP-46/71) GENERALIZED ONE DIMENSIONAL MAGNETOHYDRODYNAMIC COMPUTER CODE FOR PARTIALLY IONIZED HYDROGEN OR HELIUM PLASMAS. Hofmann, F. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Feb 1971. 42p. Dep. NTIS (U. S. Sales Only).

A computer program was developed to solve the "generalized" MHD equations (including electron inertia and drift velocity effects) for four fluids in one dimension. The physical model and numerical methods are discussed. Results of a typical calculation are presented. (auth)

33264 (MATT-Trans-47) TRANSPORT PHENOMENA IN A RAREFIED PLASMA IN TOROIDAL MAGNETIC TRAPS. Galeev, A. A.; Sagdeev, R. Z. Translated by Katherine E. Weimer (Princeton Univ., N. J.), from Zh. Eksp. Teor. Fiz.; 53: 348-59 (1967). 20p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 21: 37412. (M.O.W.)

33265 (NYO-1480-167) NUMERICAL SOLUTION OF NONLINEAR BOUNDARY VALUE PROBLEMS USING REFLECTION. Snider, A. D. (New York Univ., N. Y. AEC Computing and Applied Mathematics Center). Apr 1971. Contract AT(30-1)-1480. 101p. Dep. NTIS.

The results of using the reflection property of solutions of elliptic partial differential equations to determine the boundary conditions to the transformed difference equations are discussed. The basic idea is analyzed theoretically, and its applicability to a special class of two-dimensional problems is illustrated. The procedure is then applied to a simple plasma-containment problem and to the two- and three-dimensional axially symmetric vena contracta models. The results are compared with those of Bloch, and it is seen that the reflection scheme requires about one-tenth as many iterations for convergence as the method of steepest descent. New computations for the contraction coefficient are presented. (auth)

33266 (ORNL-tr-2432) COLLECTIVE DECELERATION OF A BEAM OF ENERGETIC RELATIVISTIC ELECTRONS IN A DENSE PLASMA TARGET. Rudakov, L. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Atomnoi Energii). Translated for Oak Ridge National Lab., Tenn., from report IAE-2004. 27p. Dep. NTIS (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 25: 14292. (M.O.W.)

33267 ANOMALOUS RESISTIVITY DUE TO ELECTROSTATIC TURBULENCE. Gary, S. Peter (Coll. of William and Mary, Williamsburg, Va.); Paul, J. W. M. Phys. Rev. Lett.; 26: 1097-1100(3 May 1971).

A general expression is calculated for anomalous resistivity due to weak electrostatic turbulence in a plasma. In the case of ion acoustic turbulence, it is shown to reduce to the heuristic result of Sagdeev. Applications to perpendicular collisionless shock experiments are discussed. (auth)

33268 ANOMALOUSLY RAPID SKIN-CURRENT PENETRATION AND HEATING IN PULSED-PLASMA EXPERIMENTS. Hirose, A.; Alexeff, I. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 26: 949-52(19 Apr 1971).

Electrostatic instabilities in a plasma having electrons flowing along a magnetic field are generated by a shear in the electron drift velocity. This can cause an effective resistivity much higher than the Buneman value and, consequently, increase the rates of penetration of a skin current and of heating. (auth)

33269 ON DOUBLE-STRUCTURED, PERPENDICULAR, MAGNETO-PLASMA SHOCK WAVES. Woods, L. C. (Oxford Univ.). Plasma Phys.; 13: 289-302(Apr 1971).

A theory is presented for double-structured shock waves that possess a precursor "foot" due to the reflection of ions from a resistive shock front. Above a critical Alfvén–Mach number M_A the reflected ions generate a streaming instability with the electrons that results in the flow of a transverse electric current and a change in the magnetic field well ahead of the resistive front. The electrons in the foot are preheated by mixing with some hot

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downstream electrons that are assumed to be drawn forwards by the reflected ions. This model enables M_A to be calculated as a function of β_1, the upstream plasma beta. (auth) (UK)

33270 SIMILARITY RULES IN PLASMA PHYSICS. Lacina, J. (Inst. of Plasma Physics, Prague). Plasma Phys.; 13: 303-12(Apr 1971).

A complete set of criteria determining the similarity of physical phenomena in a plasma is derived; the discussion concerns both the similarity of collisionless plasma and collisional plasma. By application of these criteria to fusion confinement of hot plasma it is shown that, for similar experiments, the plasma density $n \propto B_{ex}^2$, the containment time $\tau \propto 1/B_{ex}$, where B_{ex} is an external magnetic field; thus the determining factor for controlled fusion, the product $n \cdot \tau$ is growing proportionally with the intensity of the external magnetic field. (auth) (UK)

33271 SMALL-AMPLITUDE OSCILLATIONS IN A SYSTEM OF A RELATIVISTIC ELECTRON BEAM PENETRATING A PLASMA. Adlam, J. H. (United Kingdom Atomic Energy Authority, Culham, Eng.). Plasma Phys.; 13: 329-45(Apr 1971).

The dispersion curves (frequency against wave number) are calculated for a relativistic electron beam penetrating a plasma using general equations. These curves are compared with those obtained using the quasi-static approximation for the same conditions. It is found that this approximation is in error for beam energies greater than 80 kV. The case of a narrow electron beam moving along the axis of a plasma cylinder is considered, and it is found that an unstable mode exists in which a considerable fraction of the energy of the oscillating mode is in the kinetic energy of plasma ions. For a practical case, with an electron beam of 13.6 A and 80 kV, the ions attain an energy of the order of 400 eV before nonlinear effects limit further growth of the instability. (auth) (UK)

33272 ANOMALOUS RESISTANCE OF PLASMA IN A STRONG MAGNETIC FIELD. Sizonenko, V. L.; Stepanov, K. N. (Kharkov State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 16: 429-37(Mar 1971). (In Russian).

Anomalous resistance and turbulent heating of strongly nonisothermic ($T_e \gg T_i$) plasma placed in a strong magnetic field ($\omega_{He} \gg \omega_{pe}$), which are conditioned by electron scattering by "beats" of ion-sound turbulent pulsations, are considered. The level of turbulent noises is estimated from the condition that stabilization of ion-sound instability starts when resonance electrons responsible for oscillation swing are beat out under the oscillation effect from phase resonance with a wave during the time of the oscillation. In this case, electron velocity u_e in the external field E is shown to be equal to $u_e = v_{Te}(eE/m_e v_{Te}\omega_{pi})^{1/2}$, where $v_{Te} = (T_e/m_e)^{1/2}$ i.e. u_e is practically independent of E. It also follows that plasma resistivity is practically proportional to E. This ratio is in good quantitative agreement with the results of experiments on Tokamak TM-3. Plasma electron and ion heating velocities are estimated, and essentially, the ions are shown to be heated quicker than the electrons. (auth)

33273 ANOMALOUS VISCOSITY AS A POSSIBLE EXPLANATION FOR AN ANOMALOUS PLASMA SKIN EFFECT. Schmidt, J.; Yoshikawa, S. (Princeton Univ., N. J.). Phys. Rev. Lett.; 26: 753-6(29 Mar 1971).

Anomalous viscosity of electrons across the magnetic field in plasmas is calculated, assuming that the electrostatic ion acoustic wave is excited by the drift velocity of electrons parallel to the magnetic field lines. The mean free path of the wave perpendicular to the magnetic field is estimated. The momentum transfer rate between waves and electrons, τ^{-1}, was also calculated from quasi-linear theory. The anomalous (kinematic) viscosity was then estimated as $l^2\tau^{-1}$. The theory appears to explain the experimentally observed results of the anomalous skin effect. (auth)

33274 NONLINEAR INTERACTION OF A SMALL COLD BEAM AND A PLASMA. O'Neil, T. M.; Winfrey, J. H.; Malmberg, J. H. (Univ. of California, San Diego, La Jolla). Phys. Fluids; 14: No. 6, 1204-12(Jun 1971).

Recently, a simple model was proposed for the nonlinear interaction of a low-density monoenergetic electron beam and a relatively cold infinite homogeneous one-dimensional plasma. The essential feature of this model is the observation that after several e-foldings the bandwidth of the growing waves is so narrow that the electrons interact with a very nearly pure sinusoidal field. In terms of this single-wave model, a properly scaled solution of the nonlinear beam–plasma problem which depends analytically on all the basic parameters of the problem (i.e., plasma density, beam density, plasma thermal velocity, and beam drift velocity) is presented. This solution shows that the single wave grows exponentially at the linear growth rate until the beam electrons are trapped. At that time the wave amplitude stops growing and begins to oscillate about a mean value. During the trapping process the beam electrons are bunched in space and a power spectrum of the higher harmonics of the electric field is produced. Both the oscillation in wave amplitude and the power spectrum are given a simple physical interpretation. (auth)

33275 RETURN CURRENT INDUCED BY A RELATIVISTIC BEAM PROPAGATING IN A MAGNETIZED PLASMA. Lee, Roswell; Sudan, R. N. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids; 14: No. 6, 1213-25(Jun 1971).

The propagation of a high-current relativistic beam in a cold magnetized plasma is investigated using a model developed by Hammer and Rostoker for the unmagnetized case. In this model, the beam electrons are assumed to be undeflected from their zero-order orbits and the fields associated with the beam are switched on at time t = 0. The return current induced in the plasma is calculated as a function of beam and plasma parameters. It is demonstrated that the return current does not extend indefinitely but dies away inversely as the distance from the head of the beam with a characteristic length $L_n = v_0\tau a^2/\lambda_E^2$, where v_0 and a are the beam velocity and radius, τ is a phenomenological momentum relaxation time for the plasma electrons $\lambda_E = c/\omega_p$, and ω_p is the plasma frequency of the plasma electrons. When the beam is injected either parallel or perpendicular to a static magnetic field B_0, it is found to be magnetically neutralized by a return current over a length of order L_n if $a^2/[\lambda_E^2(1 + \Omega^2/\omega_p^2)] \gg 1$, where $\Omega = eB_0/m_0c$. (auth)

33276 THEORY OF COLLISION DOMINATED ELECTRON DENSITY FLUCTUATIONS IN A PLASMA WITH APPLICATIONS TO INCOHERENT SCATTERING. Hagfors, T.; Brockelman, R. A. (Massachusetts Inst. of Tech., Lexington). Phys. Fluids; 14: No. 6, 1143-51(Jun 1971).

The problem of thermal electron density fluctuations in a weakly ionized gas is considered from the point of view of particle diffusion in single particle phase space (μ space). When ion–neutral and electron–neutral two-body collisions constitute the only important force on the charged particles apart from an electrostatic self-consistent field, it is shown how the fluctuation theory may be developed from a transition probability describing the random walk of a single charged particle in the absence of the interaction field. Specific calculations of thermally excited low-frequency electron density fluctuation spectra are carried out on the assumption that the random walk may be described in terms of classical Brownian motion or in terms of a combination of free flight and classical Brownian motion. The latter model is shown to be a first approximation to a more exact solution which may be obtained by solving an integral equation for the transition probability. First-order calculations are carried out for the case where the ion–neutral collisions may be treated as hard sphere elastic ones. The computational results are compared with those of earlier theories of fluctuations in a weakly ionized gas. (auth)

33277 KINETIC THEORY OF PLASMA IN A MAGNETIC FIELD. Price, John C. (Goddard Space Flight Center, Greenbelt, Md.). Phys. Fluids; 14: No. 6, 1152-7(Jun 1971).

The Krylov–Bogolyubov transformation is used to simplify the guiding center equations for a charged particle in electric and magnetic fields. The resulting transformation of variables is then applied to the Vlasov distribution function, yielding a magnetic Vlasov equation which describes the low-frequency behavior of a system with no statistical effects. The equation is generalized to include effects of high- and low-frequency fluctuations by a procedure developed by Klimontovich and Dupree. A consistent treatment of the conservation laws and Maxwell's equations is given to complete the kinetic description. (auth)

33278 VISCOUS INNER STRUCTURE OF ZERO PRANDTL NUMBER SHOCKS. Cohen, Ira M.; Moraff, Charles A. (Univ. of Pennsylvania, Philadelphia). Phys. Fluids; 14: No. 6, 1279-80(Jun 1971).

Inviscid, heat conducting (zero Prandtl number) gasdynamic shock waves have a discontinuous jump (inner shock) in velocity for all but very weak shocks. The viscous structure of this inner isothermal discontinuity is obtained here explicitly. (auth)

33279 GENERALIZATION OF REFLECTED SHOCK CALCULATIONS. Kim, Yong Wook (Lehigh Univ., Bethlehem, Pa.). Phys. Fluids; 14: No. 6, 1280-2(Jun 1971).

A generalized method of reflected shock calculations, without the usual assumption of zero flow speed, is shown to remove the outstanding discrepancy between the calculated and observed temperatures in the spectroscopic regime. (auth)

33280 COLLISION FREE SHOCK FORMATION IN FINITE TEMPERATURE PLASMAS. Auer, P. L.; Evers, W. H. Jr.

(Cornell Univ., Ithaca, N. Y.). Phys. Fluids; 14: No. 6, 1177-82(Jun 1971).

A one-dimensional macro-particle code is used to investigate the effect of finite initial ion temperature on large amplitude magnetosonic disturbances. Time-dependent piston problems closely related to the earlier work of Auer, Hurwitz, and Kilb are studied. It is shown that at even relatively small plasma pressure to magnetic pressure ratios, large scale field fluctuations accompanying orbit crossings produce quasi-stationary shocks for all values of Mach numbers investigated. This is in contrast to cold plasma results, where similar results were observed only if the Mach number was chosen well in excess of the critical value ($M_{A,cr} = 2$). The mechanism of electron heating is not treated in this study. (auth)

33281 STATIONARY ONE-DIMENSIONAL MOTION OF A CHARGED-PARTICLE BEAM. Strongin, M. P.; Uryukov, B. A. (Inst. of Thermophysics, Novosibirsk, USSR). Izv. Sib. Otd. Akad. Nauk SSSR, No. 13, Ser. Tekh. Nauk; No. 3, 13-18(1970). (In Russian).

The problem of the simultaneous motion of positive and negative particles was investigated in a 1964 paper on electrostatic rocket propellants on the basis of the hydrodynamic approximation for the electrons, assuming that the ion parameters were constant. In a second part of the study the isothermal flow of the ion and electron gas was examined under steady-state conditions. In view of the ambiguous nature of the solution obtained, the problem was re-examined, considering the motion of the positively and negatively charged particles in the noncollision and nondissipative approximations under steady-state conditions. A system of equations was derived for the collisionless approximation, limited by the single-velocity approximation for the distribution function. The one-dimensional steady-state problem of the simultaneous motion of the beam of positively and negatively charged particles was also examined under the assumption that ideal gases of these particles interact electrostatically. (TTT)

33282 STUDY OF ELECTRON–NEUTRAL COLLISIONS IN POST-DISCHARGE PLASMAS BY THE WAVE-INTERACTION METHOD. Sol, Charles; Boulmer, Jacques (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 272: No. 12, 727-30 (22 Mar 1971). (In French).

It is shown that it is necessary to consider the effective field in the center of the plasma in order to determine the increase in electron temperature T_e due to ultrahigh frequency heating. This field is generally sensibly less than the more usually used nonperturbed field. The influence of variations in electron density with T_e on the absolute collision frequency was established. (auth) (France)

33283 MECHANICAL AND ELECTRICAL CHARACTERISTICS OF LAMINAR, ATMOSPHERIC, PLASMA-FLUID ARC JETS. Allen, Jonathan Brandon. Philadelphia; Univ. of Pennsylvania (1970). 113p. University Microfilms Order No. 71-7774. $_{25}$Thesis.

Several questions of interest are discussed concerning the physical mechanisms which are dominant in a laminar, atmospheric pressure, argon plasma arc jet. The fluid mechanical equations are developed and discussed. An approximate set of equations are solved numerically, and the results are interpreted. Then two analytic models are proposed, dependent on whether radiation or conduction is the dominant loss mechanism. A third model is developed to describe the unusual stability at the plasma column wall. Many approximations are used, however, the numerical results qualitatively agree with the models. Due to a lack of experimental results, a more accurate check was impossible. (Diss. Abstr. Int., B)

Production

33284 (NRC-TT-1450) LIGHT SPARK AS A MINIATURE EXPLOSION. Askar'yan, G. A.; Raizer, Yu. P. Translated by V. Poppe (National Research Council of Canada, Ottawa), from Priroda; No. 6, 60-5(1968). 14p. Dep. NTIS (U. S. Sales Only).

A brief discussion is given for the creation of a spark by focused laser beams. The expansion properties of this light spark are discussed. (M.O.W.)

33285 SPONTANEOUS MAGNETIC FIELDS IN LASER-PRODUCED PLASMAS. Stamper, J. A. (Naval Research Lab., Washington, D. C.); Papadopoulos, K.; Sudan, R. N.; (and others). Phys. Rev. Lett.; 26: 1012-15(26 Apr 1971).

Spontaneously generated magnetic fields of the order of a kilogauss were observed in a laser-produced plasma, using a variety of targets and background pressures. The generation of these magnetic fields is explained in terms of thermoelectric currents associated with large temperature gradients near the target. (auth)

33286 PROCESSES AND DEVICES FOR PLASMA PRODUCTION. Foex, Marc; Delmas, Robert; Bonet, Claude (to Agence Nationale de Valorisation de la Recherche). French Patent 1,600,278. 20 Jul 1970. Filed 31 Dec 1968. (In French).

This invention concerns the means and the equipment for producing plasmas in gaseous flows. Several flows are made to converge. At least one of these flows is produced by an intermediate nozzle, without its own electrical supply; one of its parts is in contact with the corresponding flow and is electrically conducting; this part is interposed in a normally open electrical circuit, which has an electrical supply. A decrease in electrical resistance is produced in these flows outside the nozzle, such that the electrical circuit can be closed by the intermediate of these flows. One of the flows envisaged will be formed by a plasma torch with at least one electrode interposed in the electrical circuit. (auth) (France)

33287 NEW OBSERVATIONS OF DIELECTRIC BREAKDOWN IN AIR INDUCED BY A FOCUSED Nd^{3+}-GLASS LASER WITH VARIOUS PULSE WIDTHS. Wang, Charles C.; Davis, L. I, Jr. (Ford Motor Co., Dearborn). Phys. Rev. Lett.; 26: 822-5 (5 Apr 1971).

Dielectric breakdown in air induced by a train of subnanosecond laser pulses was found to occur as a sequence of strong point explosions, with each pulse producing breakdown at a different spot. The angular dependence of the scattered laser light was found to be due to the reflection and diffraction from the breakdown spots, which were approximately spherical with diameters of about 9 μm. For atmospheric breakdown, analysis of results indicates that a plasma density as high as 7×10^{20} electrons/cm^3 was created in the breakdown region. (auth)

33288 HEAT FLUXES TO THE ELECTRODES WITH THE LAMINAR FLOW OF AN ARGON–POTASSIUM PLASMA IN THE ELECTRICAL FIELD OF A DISCHARGE. Petukhov, B. S.; Ivanov, E. F.; Nikolaev, G. N.; Zhilin, V. G.; Krymov, G. A. (High Temperature Inst., Moscow). High Temp. (USSR) (Engl. Transl.); 8: 521-6(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 557-63(May-Jun 1970).

A method for investigation was developed and an experimental unit built for measurement of heat transfer from an argon–potassium plasma to the electrode, between which a stationary electrical discharge is maintained. The electrodes, with special heat-measurement devices, are mounted in the wall of a rectangular channel, installed at the outlet from a plasmatron. Data were obtained on the conditions for the existence of various types of discharges, on the value of the heat fluxes to the cathode and the anode, on the energy balance of the discharge, and on the role of the layers near the electrodes in the heating of the electrode. (auth)

33289 EROSION CHARACTERISTICS OF A QUASI-STATIONARY PLASMA ACCELERATOR. Dorodnov, A. M.; Ivashkin, A. B.; Kozlov, N. P.; Reshetnikov, N. N. (Moscow Higher Technical School). High Temp. (USSR) (Engl. Transl.); 8: 466-71(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 492-9(May-Jun 1970).

Experimental data relating to the erosion of the inner and outer electrodes in a coaxial plasma accelerator with a discharge current I_d of 1 to 12 kA and various discharge times and polarities are presented. The erosion of an inner cathode averages $m_c = 10^{-5}$ g/C, while that of an inner anode is an order higher. The manner in which the flow of eroded material from the inner electrode varies with time is the same for both anode and cathode; it is associated with the progress of thermal processes in the electrode. The erosion of the outer electrode is divided into two components, axial and radial, the first being an order smaller than the second and averaging $m_c = 10^{-6}$ g/C at a cathode and $m_a = 0.5 \times 10^{-6}$ g/C at an anode. The distribution of radial erosion along the outer electrode is different for anode and cathode; it qualitatively coincides with the distribution of thermal flux and current density and is due to the anisotropy of conductivity within the accelerator cavity, as particularly manifested in the $\omega\tau$ layer near the electrode. (auth)

33290 CASCADE EXCITATION OF HYDROGEN ATOMS IN PLASMA IN A MAGNETIC TRAP. Grechukhin, D. P.; Karpushkina, E. I. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: 229-42(Mar 1971).

An analysis is made of the cascade excitation of hydrogen atoms traversing a magnetic trap with velocity 2×10^8 cm/sec so that the Lorentz field can ionize atoms in states with principal quantum

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number n ~ 10 to 14 and density 10^{10} to 10^{12} cm^{-3}. It is assumed that the total plasma density is equal to the sum of the electron and ion densities and that the plasma is effectively cold, i.e., the atoms have the same relative velocity with respect to both ions and electrons. The results of the analysis allow one to estimate the efficiency of the cascade mechanism in increasing the population of highly excited states as a function of plasma density and the transit time of the atoms through the magnetic trap; the population is defined as the ratio of the number of atoms in any state with given n to the total number of atoms in the beam. Values for the total ion production of the cascade chains are presented graphically. Estimates are made of the direct ionization of excited atoms by collisions with plasma ions and by tunnel ionization by the Lorentz field of the trap. The first process contributes a few percent to the total ion production, the second can change the production by 15 to 20% (for a magnetic field in the trap H ≈ 15 kG and plasma path ~20 to 40 cm). (auth) (UK)

33291 ELECTRICAL BREAKDOWN OF THE GAP BETWEEN PLASMA AND COLD ELECTRODES BY AN INDUCED FIELD. Lebedev, E. F.; Nikuev, Yu. A. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: 445-8(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 469-73(May-Jun 1970).

The electrical breakdown of the interelectrode gap in an argon-containing plasma device is described for a case in which the rate of ionization from an external source is of the order of 10^{21} $cm^{-3} \cdot sec^{-1}$; a self-contained discharge is stably maintained as a result of an induced electric field. The ratio of the electron concentrations in the gap before and after breakdown is calculated from measured current densities; the ratio rises as high as 600. (auth)

33292 CHARACTERISTICS OF BEAM-GENERATED SYSTEMS. McCorkle, Richard Anthony. Raleigh, N. C.; North Carolina State Univ. (1970). 158p. University Microfilms Order No. 71-10,257.

Thesis.

The production and maintenance of quiet, electrostatically self-focusing thin electron streams were achieved. This task required detailed attention to such factors as gun design, collector assembly design, tube construction, and material selection as well as the selection of proper modes of operation. The basic nature of the fundamental processes operative in such a system was examined experimentally by means of particle energy analyzers developed in the course of study. Data provided by this system permitted decisions to be made on the energy and spatial distributions of ambient charged particles produced by the beam. Furthermore, experimental determinations of some of the conditions under which oscillatory behavior might be expected in such systems were made. Paralleling the experimental work was the development of an adequate theoretical description of the direct-current nature of the beam-generated system based on an analysis of the physical processes important in such systems. The model constructed was found to be adequate for understanding and interpreting the data collected. Agreement between theory and experiment was obtained. The theoretical model is considered to be an adequate foundation from which theoretical work may be done on the oscillatory nature of such beam-generated systems. Finally, an experimental study was made of the feasibility of utilizing such streams in a helical geometry to generate, interior to the helix, a quiet plasma region in which basic measurements on plasma propagation properties could be made. (Diss. Abstr. Int., B)

33293 MODEL AND CALCULATIONS FOR LASER-INDUCED PLASMAS. Peery, Larry Joe. Stillwater, Okla.; Oklahoma State Univ. (1970). 207p. University Microfilms Order No. 71-11,246.

Thesis.

In order to study laser-induced plasmas, a theoretical model is proposed and investigated. This model has, as a basis, the macroscopic equations that govern the evolution of an aluminum plasma. These equations include an equation of state for aluminum. The existing equations of state were found to be inadequate throughout part of the temperature-density range that is encountered when the plasma is produced from the metal at room temperature. This inadequacy required the development of an improved equation of state. The improved equation of state provides a means of describing the plasma properties at the low temperatures and the high densities that are present in the problem. In addition, values for the secondary characteristics of the plasma were needed before a solution of the flow equations could be attempted. Calculations were developed for these characteristics, which include such properties as viscosity, thermal conductivity, electrical conductivity, and the optical properties. These calculations make it possible to evaluate these quantities over the extended thermodynamic range of the present problem. All of the applicable equations that govern the transient plasma were then adapted to a two-dimensional computer model with cylindrical geometry. Calculations on this model were then performed for laser-induced plasmas. (TSS) (Diss. Abstr. Int., B)

Stability

Refer also to abstract 33338.

33294 (EUR-CEA-FC-581) DYNAMIC STABILIZATION OF THE DRIFT-DISSIPATIVE INSTABILITY USING AN INHOMOGENEOUS hf FIELD. Lepechinsky, D.; Rolland, P.; Teichmann, J. (European Atomic Energy Community. Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jan 1971. 13p. (In French). Dep. NTIS (U. S. Sales Only).

A new method of stabilizing dissipative-drift instability in a partially ionized plasma is studied. The method involves a hf electric field parallel to the static magnetic field, but presenting a gradient in the radial direction of the cylindrical plasma column. The dispersion equation is obtained using the two-fluid macroscopic equations with scalar pressure. It is shown that better stability is obtained than with a homogeneous high-frequency field, in particular for a field frequency superior to the collision frequency; this stability can be obtained with relatively low electric field strengths. (France)

33295 (LA-4604) LASER-INDUCED PLASMA INSTABILITY. Freidberg, J. P.; Marder, B. M. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 7p. Dep. NTIS.

A simple picture is presented of the instability induced by an electric field oscillating near the plasma frequency. (auth)

33296 (MATT-Trans-42) DRIFT-DISSIPATIVE INSTABILITIES OF TRAPPED PARTICLES IN TOROIDAL SYSTEMS. Galeev, A. A.; Sagdeev, R. Z. Translated by Katherine E. Weimer (Princeton Univ., N. J.), from Dokl. Akad. Nauk SSSR; 180: 839-42(1968). 24p. Dep. NTIS.

Drift oscillations are studied in detail in the framework of the Boltzmann equation with a Landau collision term. The conditions under which the non-Maxwellian nature of the trapped electron velocity distribution, the presence of a current, or simply a density inhomogeneity leads to spontaneous growth of drift oscillations are examined. It is shown that, in a dense plasma, the growth rate is decreased and collisionless transit-ion Landau damping leads to stabilization of the more dangerous branch of the instability. In a rarefied plasma, high-frequency electric and magnetic fields can be used for stabilization. (auth)

33297 INSTABILITY OF POWERFUL GAS DISCHARGE. Pis'mennyi, V. D.; Rakhimov, A. T. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 196: 562-4(Jan 1971). (In Russian).

Rapid current variations of a gas discharge taking place under conditions in which the radiation input into the plasma energy balance is of great importance is discussed. The energy balance of isothermal and optically transparent plasma is mathematically analyzed. The solution obtained is analyzed for the case of hydrogen plasma. (R.V.J.)

33298 SOME PROBLEMS OF CONTROL BY MEANS OF AN ELECTRIC FIELD. Samoilenko, Yu. I. Kibernetika; No. 3, 48-53(May-Jun 1970). (In Russian).

The fundamental principles of automatic control of electromechanical systems are examined on the basis of parameters distributed by the control medium; electromagnetic interactions were considered as contact between the medium and the controlled system. Optimization of the control device makes it necessary to find an operator in the control field which will yield absolute minimum losses for most of the permissible operators. The media examined included nonrelativistic electrons in motion and ionized gases. The problems arising from the stable confinement of liquid and gaseous conductors by electromagnetic fields were identified; they are due to the establishment of the equilibrium and of stability in the system. These problems do not lend themselves to exact analytical solutions but computerized approximations may be used. (TTT)

33299 STABILITY THEORY OF GENERAL PLASMA EQUILIBRIA. II. MULTIPOLES. Hastie, R. J.; Taylor, J. B. (Culham Lab., Abingdon, Eng.). Plasma Phys.; 13: 265-88 (Apr 1971).

A general method for investigating stability and oscillation of zero-β magnetically confined plasma, which was developed in Part I, is applied to the multipole configuration. Simpler versions of the general theory are first introduced for each of three important frequency regimes. These are then used to determine the spectrum of oscillations of plasma in a multipole and to derive qualitatively, the full dispersion diagram. The oscillations include

fluid instabilities and both positive and negative energy waves which may be stable or unstable due to resonant-particle interaction. The dispersion diagrams include branches representing all previously known modes of oscillation such as flute modes, trapped-particle modes, drift and drift-acoustic modes, drift trapped particle modes, etc. as well as several new modes and shows clearly the relations between these branches. In addition to the qualitative dispersion diagrams the eigenvalue equation appropriate to each branch is given in a form suitable for future numerical investigations. (auth) (UK)

33300 RESISTIVE EQUILIBRIUM MODEL IN A TOKAMAK. Andreoletti, J. (CEN, Fontenay-aux-Roses, France). Plasma Phys.; 13: 313-27(Apr 1971). (In French).

The quasi-stationary state of the plasma in a Tokamak is determined by associating to the equations of magnetohydrodynamic equilibrium, Ohm's law (with a tensor conductivity varying as $T^{\frac{3}{2}}$), the equation of state, and a linear relation between the relative gradients of temperature and of density. The various quantities of a family of states are obtained, including the distributions of temperature and of density, the electrostatic potential and the velocity of the plasma. Applying to these states various stability criteria relative to resistive and nonresistive motions results essentially in the so-called Kruskal–Shafranov limit. (auth) (UK)

33301 CRITICAL β TOROIDAL EQUILIBRIUM. Strauss, H. R. (Univ. of Texas, Austin). Phys. Rev. Lett.; 26: 616-18 (15 Mar 1971).

Toroidal, ideal magnetohydrodynamic equilibrium, with magnetic surfaces enclosing a single magnetic axis, is possibly for arbitrary β (plasma pressure/poloidal magnetic pressure). When β exceeds about one-half the aspect ratio, the toroidal current reverses on the inner edge of the plasma. The poloidal current balances the pressure gradient. (auth)

33302 ION WAVE INSTABILITY IN AN ELECTROSTATIC SHOCK. Abas, S.; Gary, S. P. (University Coll. of Wales, Aberystwyth). Plasma Phys.; 13: 262-4(Mar 1971).

A collisionless electrostatic shock in a plasma gives rise to reflection of ions from the shock front, leading in turn to a precursor shock. Under certain conditions instabilities can arise and turbulence set in. Instabilities arising in linear longitudinal waves were investigated by employing a double-humped ion-velocity distribution, and numerical values were obtained for the linear dispersion relation. (UK)

33303 DYNAMIC STABILIZATION OF DRIFT WAVES IN A COLLISIONLESS PLASMA BY AC ELECTRIC FIELDS. Dobrowolny, M. (EURATOM–CNEN, Frascati, Italy). Plasma Phys.; 13: 199-212(Mar 1971).

The influence of an ac electric field parallel to the confining magnetic field on low-frequency instabilities in an inhomogeneous collisionless low-β plasma was studied. A general dispersion relation was derived, valid for small amplitudes of the time varying field, for frequencies of modulation and plasma mode frequencies much smaller than the ion cyclotron frequency. The formalism was applied to a variety of drift instabilities and the flute instability in a maxwellian plasma. Possibilities of dynamic stabilization were found for the majority of the drift waves. Corresponding stability criteria in terms of the electric field amplitude and conditions on the modulation frequency are given. (auth) (UK)

33304 NONLINEAR EXPLOSIVE ION BEAM PLASMA INTERACTION. Dum, Christian T.; Ott, Edward (Cornell Univ., Ithaca, N. Y.). Plasma Phys.; 13: 177-90(Mar 1971).

The explosive three-wave interaction between beam modes and ion acoustic waves is studied. Coupling coefficients and growth times for the nonlinear interactions are calculated and discussed. Both the case of a coherent triplet and that of many interacting waves are considered. The effects of the commonly used assumptions of quasi neutrality and a massless electron fluid on the nonlinear wave dynamics are investigated, and the effects of finite geometry are considered. (auth) (UK)

33305 INSTABILITY THEORY OF SPATIALLY SEPARATED PLASMA BEAMS. Bogdanov, E. P.; Orlov, L. K.; Romanov, Yu. A. (Gorky State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: 228-33(1971). (In Russian).

The amplification of electromagnetic waves in the system consisting of two uniform spatially separated semibounded plasma beams is investigated in the quasi-hydrodynamic approximation. The regions of existence of spatially increasing waves, their increments, phase velocities, and field structure are found at different values of collision frequencies and thermal velocities of the plasma particles. (auth)

33306 FINITE BETA EQUILIBRIA IN AXIALLY SYMMETRIC TOROIDAL PLASMA CONTAINMENT DEVICES. Fisher, S. (New York Univ., N. Y.); Killeen, J. Phys. Fluids; 14: No. 6, 1240-6(Jun 1971).

Numerical methods are applied to solve the guiding-center fluid equations, with isotropic and anisotropic pressure, in an axisymmetric toroidal configuration. The shape and structure of equilibrium magnetic flux surfaces with arbitrary plasma beta and arbitrary toroidal curvature are calculated. A comparison with the vacuum magnetic fields shows that for some pressure distributions the plasma markedly distorts the magnetic field. For other distributions the magnetic mirror instability limits the maximum allowable plasma beta. It is also found that with isotropic pressure the maximum allowable beta is much higher than with slightly anisotropic pressures. (auth)

33307 FEEDBACK CONTROL OF PLASMA FLUTES WITH FINITE ENFORCED ELECTRODES. Crowley, Joseph M. (Univ. of Illinois, Urbana). Phys. Fluids; 14: No. 6, 1285-7(Jun 1971).

The finite size of enforcer electrodes in the feedback control of a low-density flute instability limits the maximum density that can be obtained in an experiment. (auth)

33308 IDENTIFICATION OF RESISTIVE DRIFT WAVES IN THE SPHERATOR, AND THEIR STABILIZATION BY SHEAR. Pacher, Horst D.; von Goeler, S. (Princeton Univ., N. J.). Phys. Fluids; 14: No. 6, 1268-79(Jun 1971).

The observation of resistive drift waves in plasmas produced in the sheared magnetic field of the spherator is reported. The plasmas were produced by electron cyclotron heating, at a density of 10^{10} to $10^{11}/cm^3$ and electron temperatures ≤ 1 eV. An investigation of oscillation amplitude demonstrates the existence of a stable regime (relative amplitude $\leq 0.5\%$) in toroidal fields near the condition of maximum shear (poloidal field and toroidal field approximately equal). For the purpose of further identification of the modes, experiments were carried out in a marginally unstable regime, resulting in nonturbulent single modes. An approximate theory of nonlocal normal modes using an average radial width is derived and is confirmed by comparison in a special case with a more accurate calculation taking into account the radial dependence. This theory predicts the expected wave parameters for the most unstable modes. The wave parameters of the single modes are measured for the case of argon, and are found to be in excellent agreement with the frequencies and wavelengths predicted for the most unstable modes. Finally, the theory predicts that plasmas of low electron temperature, low ion mass, sharp density gradient, and high density should be the most unstable to resistive drift waves. A series of experiments in which these parameters were varied agrees with these predictions. (auth)

33309 RESISTIVE INSTABILITY OF THE SHEET PINCH. Van Hoven, Gerard; Cross, Mark A. (Univ. of California, Irvine). Phys. Fluids; 14: No. 6, 1141-2(Jun 1971).

An investigation of the linear "tearing mode" instability of the sheet pinch with uniform resistivity is described. A first integral of the coupled perturbation equations for magnetic fields and fluid velocities is used to find constraints on the growth rate which detail the possible regimes of instability. The existence of pure exponential growth for long wavelengths is shown explicitly in two examples. (auth)

33310 CONDITIONS FOR THE APPEARANCE OF IONIZATION INSTABILITY IN NONSTEADY-STATE PLASMA IN THE ABSENCE OF THE TWO-TEMPERATURE APPROXIMATION. Kruzhilin, N. A.; Yakubov, I. T. (Inst. of High Temperatures, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 675-8(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 712-15(Jul-Aug 1970).

The development of electron-density fluctuations in crossed E–H fields against a homogeneous nonsteady-state background is considered under conditions for which T_e and n_e are not related by the Saha formula. The kinetics of stepped ionization is used, with allowance for radiation transfer. Estimation equations are derived that yield the relation between the time required for inhomogeneities to develop and the time required for relaxation of the background under various conditions. It is noted that the growth of fluctuations is also possible for $H = 0$. (auth)

33311 POSSIBILITY OF SUPPRESSING CURRENT-CONVECTIVE INSTABILITY OF A POSITIVE COLUMN IN A MAGNETIC FIELD BY MEANS OF A SYSTEM OF FEEDBACKS. Arsenin, V. V. (Inst. of Atomic Energy, Moscow). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 843-5(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 899-901(Jul-Aug 1970).

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The positive column of a gas discharge in a magnetic field is used for the study. If the magnetic field exceeds a certain critical value, a current-convective instability develops in the column. It has been shown previously that the oscillations can be stabilized using a system of feedbacks by measuring the electric potential on the plasma boundary and controlling the perturbation outside the plasma by means of the potential. Since the action of the system is equivalent to bringing a metal wall close to the plasma, it must stabilize only surface waves in which the separation of charges occurs on the plasma surface. A different method is now considered for suppressing current-convective instabilities, that of the insertion of electron sources of monitorable intensity into the plasma, which allows internal perturbations to be suppressed also. The stabilizing system was constructed from a pair of Langmuir probes coupled by means of an electronic circuit. The requirements of the circuit are obtained from an analysis of the dispersion equation. (J.C.W.)

33312 EXPERIMENTAL INVESTIGATIONS OF UNSTEADY-STATE PROCESSES IN A NONEQUILIBRIUM MIXTURE OF CESIUM AND ARGON. Novichkov, D. N.; Glebov, B. B. High Temp. (USSR) (Engl. Transl.); 8: No. 4, 659-69(Jul-Aug 1970). Translated from Teplofiz. Vys. Temp.; 8: No. 4, 695-706(Jul-Aug 1970).

Relaxation processes arising in a plasma mixture of argon and cesium were studied by applying a rectangular pulsed voltage to a fixed discharge. It was found that, even with insignificant overvoltages, the development process deviates considerably from the Saha ionization relationship. Investigation of the kinetics of the process showed that, in the relaxation process, there is no universal law governing the distribution with respect to the excited states which, even for one series of levels, differs from the Boltzmann distribution in the stage of maximum increase, n_e. The measured values of the ionization function are less than those calculated with the Bates model by ~2 orders of magnitude. (auth)

33313 EFFECT OF INNER CURRENT-CARRYING RINGS ON EQUILIBRIUM OF TOROIDAL PLASMA. Mohri, A. (Nagoya Univ., Japan); Inoue, M. Phys. Lett.; 35A: No. 2, 69-70(17 May 1971).

It is experimentally verified that inner current-carrying rings located periodically in a simple toroidal field have a favorable effect to reduce the toroidal drift of plasma. (auth)

Thermonuclear Processes

33314 (AEC-tr-7185) RESEARCH ON CONTROLLED THERMONUCLEAR REACTIONS IN THE USSR. Golovin, I. N.; Kadomtsev, B. B.; Tolok, V. T. Translation of Russian report. 33p. Dep. NTIS.

A general review of the research program on plasma physics and controlled thermonuclear research in the Soviet Union from 1950 to the present time is given. (M.O.W.)

33315 (AEC-tr-7208) FINAL SIMPLIFICATION OF WINDING PRODUCING A MAGNETIC CONFIGURATION OF THE STELLARATOR TYPE. Gourdon, Christian; Hubert, Pierre; Marty, Denis. Translated from Compt. Rend., Ser. B; 271: 843-5(Oct 1970). 5p. Dep. NTIS.

A magnetic configuration obtained by combining the following three windings is discussed: (1) a toroidal winding that produces an azimuthal field B_ϕ. (2) an assembly of l helicoidal conductors spaced evenly on a torus of large radius R_0 and small radius a. These conductors turn while making m small turns for one large turn of the torus. They carry currents that are equal and that all circulate in the same direction. (3) A winding that produces a uniform field B_z that is intended to compensate, on the average, for the component B_z produced by the heliocoidal currents. The possibility of eliminating this B_z winding is discussed. (M.O.W.)

33316 (IPPJ-DT-19) EXPERIENCE IN LARGE CAPACITY HIGH VOLTAGE SWITCHES FOR BSG PROJECT. Kawasaki, Sunao; Uchida, Taijiro (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1970. 63p. (In Japanese). Dep. NTIS (U. S. Sales Only).

High-voltage switches with large capacity were designed for the power sources of the BSG system. A throw-in vacuum switch is made of copper–tungsten alloy. Trigger pulses of 15 kV were supplied to the switch by a trigger circuit that received an external signal with 200 volts of pulse height and 5 μsec duration. The duration time of the trigger pulses was about 60 μs. Conditioning was necessary when this switch was used for voltages of 20 kV or more. Design of a crowbar switch is the same as the throw-in switch except for parallel loads. A throw-in switch with three-point gap in air was designed to improve performance of the crowbar switch and was used under the condition of 40 kV and 100 kA. Parallel operation of in-air or pressurized switches was performed to obtain plasma with several hundred volts. Thirty switches were operated in good condition. A low-inductance (large-capacity) crowbar switch (1 nH, 1 MA) was operated with load of 10 nH, being used for theta-pinch system. (Japan)

33317 (LA–4599) THE FORMULATION OF A HELICALLY SYMMETRIC MAGNETOHYDRODYNAMIC THETA PINCH PROBLEM. Weitzner, Harold (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 10p. Dep. NTIS.

In preparation for numerical computation of dissipative magnetohydrodynamic systems with helical symmetry, a model is formulated and equations are given. After some manipulations, Maxwell's equations without displacement current are rewritten in terms of the two basic helical fluxes and the two basic input functions of time, the current in the outer conductor, and the electromotive force across the gap. One possible set of fluid equations is also given. (auth)

33318 (NYO–4109-2) THE EXPERIMENTAL AND THEORETICAL INVESTIGATION OF AN INERTIAL ELECTROSTATIC CONFINEMENT DEVICE. Progress Report, June 15, 1969–March 15, 1971. (Pennsylvania State Univ., University Park). Contract AT(30-1)-4109. 19p. Dep. NTIS.

The development and use of the following two diagnostic techniques are described: (1) an electron beam probe to measure potential, and (2) analysis of Doppler-shifted spectral lines to study the presence of fast particles in the system. A general steady-state theory, based on the solution of the Vlasov equation, was used to obtain potential profiles with varying amounts of trapped particles. (M.O.W.)

33319 PRODUCTION OF HIGH ELECTROMAGNETIC ENERGIES BY COMBINED WORK OF PULSE EXCITED OSCILLATOR AND CONDENSER BATTERY. Sipailov, G. A.; Ivashin, V. V.; Loos, A. V.; Khor'kov, K. A. (Tomsk Polytechnic Inst., USSR). Elektrichestvo; No. 8, 46-9(1967). (In Russian).

For the production of quantities of electromagnetic power up to 10^6 joules for accelerators and thermonuclear devices, a bank of capacitors is conveniently utilized with the pulse generator. A brief mathematical treatment of the basic parameters of the scheme is given. The power transmitted to the load is increased by a factor of 2 to 4 by the use of the booster capacity. Powerful sources of energy, however, are not required for charging of the capacitor bank. (K.S.W.)

33320 ENGINEERING AND ENVIRONMENTAL ASPECTS OF FUSION POWER REACTORS. Postma, Herman (Oak Ridge National Lab., Tenn.). Nucl. News; 14: No. 4, 57-62(Apr 1971).

Problems associated with the manufacture of a fusion reactor are reviewed. Confinement, economic, engineering, and environmental solutions are necessary for the realization of fusion. Possible fuel cycles are discussed, with emphasis on the deuterium–tritium cycle, which has the highest reaction rate and goes at a lower energy. Parameters and criteria involving assumptions, engineering aspects, fuel resources, magnetic field, breeding, materials, radiation damage, and stored energy are discussed. A summary of radiation damage in a hypothetical MLFBR in comparison with the EBR-2 is given, using niobium vacuum wall in the MLFBR and stainless steel cladding in the EBR-2. An experiment at ORNL has been prepared with boron injected in niobium, which through (n,α) neutrons will produce enough helium (in the ranges 1 to 1500 ppM) at the projected temperature to see how niobium will react under the radiation circumstances. Inventories are given of the principal volatile radioactive isotopes and the maximum permissible air-borne contamination for each isotope for a PWR and a fusion reactor designed to deliver 2800 MW(e). The fission–fusion hybrid symbiosis is considered with the idea that the neutron-rich fusion system and the power-rich fission system will yield a great combination. (J.C.W.)

33321 MAGNETIC WELLS IN TOROIDAL SYSTEMS. Shafranov, V. D. (Inst. of Atomic Energy, Moscow). Plasma Phys.; 13: 349-52(Apr 1971).

It is shown that in toroidal plasma containment systems the condition $w'(a) > 0$ (for $p'(a) < 0$) where $w = \langle 2p + |B|^2 \rangle$ should be considered as characterizing a "magnetic well" or minimum B configuration rather than the condition $V''(\Phi) < 0$. (auth) (UK)

33322 PERISTALTIC TOKAMAK. Wort, D. J. H. (Culham Lab., Abindgon, Eng.). Plasma Phys.; 13: 258-62(Mar 1971).

The Tokamak confinement system is simple both in concept and construction, and has produced the closest approach to a reactor-type plasma of any confinement system so far. However, it has the major disadvantage of pulsed operation because of the need to induce a toroidal electric current in the plasma, and it appears that the energy storage implied by the pulsed operation of a re-

actor will exact a considerable economic penalty on the operation of a fusion power station. This note points out one method by which the Tokamak current can be maintained indefinitely, so that the device becomes a Direct Current Tokamak. (auth) (UK)

33323 FINITE BETA EQUILIBRIA OF RELATIVISTIC ELECTRON BEAMS IN TOROIDAL GEOMETRY. Ott, Edward; Sudan, R. N. (Cornell Univ., Ithaca, N. Y.). Phys. Fluids; 14: No. 6, 1226-34(Jun 1971).

Vlasov equilibria of axisymmetric toroidal plasma pinches are obtained by a perturbation expansion with the inverse aspect ratio, r_p/R, as the small parameter (r_p and R are the minor and major toroid radii). The particle distribution function is a delta function in the two constants of motion, the canonical azimuthal angular momentum and the total energy. The equilibria studied include a plasma pinch contained within a conducting toroidal vessel and a plasma ring such as might be formed by transverse injection into a mirror field. (auth)

33324 STELLARATOR WITH PARTIALLY COMPENSATED MECHANICAL STRESSES. Hubert, Pierre (EURATOM–CEA, Fontenay-aux-Roses, France). Compt. Rend., Ser. B; 272: No. 11, 661-3(15 Mar 1971). (In French).

A stellarator-type magnetic configuration constructed with toroidal helices of modulated pitch can, in certain cases, cancel the average radial force experienced by the coils. When the multipolarity is of the first order l = 1 and the ratio of the radii R/r = 8, this cancellation is obtained when the conductor describes a ratio m = 25 (small turns per large turn). (auth) (France)

Wave Phenomena

Refer also to abstract 33305.

33325 (MATT-Trans–103) ON THE POSSIBILITY OF SIMULTANEOUS TRANSFORMATION AND CHANNELING OF ENERGY IN AN INHOMOGENEOUS MEDIUM. Erokhin, N. S.; Moiseev, S. S. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). Translated for Plasma Physics Lab., Princeton Univ., N. J., from report KHFTI–70-20. 8p. Dep. NTIS.

Wave propagation in an inhomogeneous medium in the form of narrow channels was studied. The "intersection" of solutions in the vicinity of the pole of the corresponding differential equation is derived. Complete absorption of the wave in the vicinity of the pole is demonstrated. When considering thermal motion in an inhomogeneous plasma, this corresponds to 100% mutual transformation of the plasma and electromagnetic modes. (auth)

33326 (MATT-Trans–105) ANOMALOUS ABSORPTION OF ELECTROMAGNETIC WAVES BY PLASMA. Pustovalov, V. V.; Silin, V. P. Translated by Marina Naumann for Princeton Univ., N. J., from Zh. Eksp. Teor. Fiz.; 59: 2215(1970). 27p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 14373. (M.O.W.)

33327 NONLINEAR WAVES. Kadomtsev, B. B.; Karpman, V. I. (Inst. of Atomic Energy, Moscow). Usp. Fiz. Nauk; 103: 193-232(Feb 1971). (In Russian).

Basic results of the theory of nonlinear wave processes in continuous media are reported, with calculation of dispersion and dissipation effects. Attention is given to nonsteady-state processes, formation of shock and solitary waves, phenomena of self-compression, self-focusing wave pockets, and dynamic processes and stochastic wave interactions. Illustrating the above are examples from hydrodynamics, plasma physics and nonlinear optics. 73 references. (tr-auth)

33328 RESULTS OF SPATIAL BALLISTIC ECHO THEORY. Sauer, K.; Bachmann, P.; Baumgaertel, K. (Zentralinstitut fuer Elektronenphysik, Berlin). Lett. Nuovo Cim.; 1: 541-5(27 Mar 1971).

Theoretical results are given in order to explain characteristic spatial echo effects observed experimentally on electron and ion waves. A ballistic model for describing these effects is given. (M.O.W.)

33329 TRANSFORMATION OF WAVES AND EIGEN OSCILLATIONS OF AN INHOMOGENEOUS LAYER OF HOT PLASMA. Kopecky, V. (Inst. of Plasma Physics, Prague). Czech. J. Phys.; 21: 256-68(1971).

In the case of a plasma layer it is shown that in a hot plasma with inhomogeneity of density across the magnetic field there exist eigenmodes for frequencies of hybrid resonance that are combinations of two kinds of waves: The potential long waves of cold plasma and the short-wave Bernstein modes. Their coupling is due to transformation in the region of the hybrid resonance. These eigenmodes can also be traveling waves with energy transmitted in one direction by a long wave and in the opposite one by a short wave. Different types of eigenmodes and corresponding quantization conditions are obtained. (auth)

33330 REFLECTION OF WAVES WITH FREQUENCIES LESS THAN THE GYROFREQUENCY BY A DISCONTINUOUS SURFACE PARALLEL TO THE MAGNETIC FIELD. Lacoume, Jean-Louis (Univ., Paris). Compt. Rend., Ser. B; 272: 346-8(1 Feb 1971). (In French).

It is shown that ionization irregularities, aligned with the lines of force of the Earth's magnetic field, reflect Alfvén waves (anisotropic magnetohydrodynamic mode) without energy losses. This result explains how these waves are guided along the force lines of the Earth's magnetic field. (auth) (France)

33331 STUDY OF BEAM–PLASMA INTERACTION IN BOUNDED SYSTEMS. II. El-Siragy, N. M.; Pakhomov, V. I.; Zayed, K. E. (Atomic Energy Establishment, Cairo). Physica; 51: 260-4(29 Jan 1971).

The interaction of a charged-particle beam with the electrostatic surface waves propagating along a plasma cylinder and a vacuum cylinder inside the plasma is under consideration. The expressions for growth rates of the waves excited both by cold and hot beams have been obtained. (auth)

33332 SELECTED PAPERS FROM THE U.R.S.I. SYMPOSIUM ON ELECTROMAGNETIC WAVES, STRESA, ITALY, JUNE 24–29, 1968. Alta Freq.; 38: Special No., 1-387(May 1969). (In several languages). (CONF-680674).

A total of 77 papers from the symposium on electromagnetic waves given at Stresa, Italy, June 24 to 29, 1968, are presented. Subjects selected for presentation include wave propagation in inhomogeneous and anisotropic media, propagation in random media, vlf propagation, nonlinear phenomena in wave propagation, antennas, application of computers and numerical methods, and diffraction. (J.C.W.)

33333 OBSERVATION OF DIRECT NONLINEAR COUPLING OF ELECTROMAGNETIC WAVES AND ELECTROSTATIC WAVES IN A PLASMA. Phelps, David; Rynn, Nathan; Van Hoven, Gerard (Univ. of California, Irvine). Phys. Rev. Lett.; 26: 688-91(22 Mar 1971).

Experiments demonstrating resonant nonlinear electromagnetic wave excitation of electron-plasma and ion-acoustic waves in a plasma column are described. Direct verification of the wave-number selection rule and indirect measurements of the mode power levels are shown. (auth)

33334 OBSERVATIONS OF NONLINEAR LANDAU DAMPING. Gentle, K. W.; Malein, A. (Univ. of Texas, Austin). Phys. Rev. Lett.; 26: 625-8(15 Mar 1971).

Nonlinear Landau damping, the nonlinear interaction between two waves in which the beat disturbance is resonant with the particle thermal velocities, was observed for electron plasma waves. The results confirm the predictions of weak-turbulence theory. (auth)

33335 PROPAGATION OF ELECTRON CYCLOTRON WAVES ALONG A MAGNETIC BEACH. Lisitano, G. (Institut fuer Plasma Physik, Garching, Ger.). Phys. Rev. Lett.; 26: 747-50 (29 Mar 1971).

The wave-dispersion characteristic of whistler waves in a plasma is directly recorded as a function of the ratio of electron cyclotron frequency to wave frequency along their propagation path in a magnetic mirror. In the limit of small wavelengths, the dispersion characteristic approaches that of plane waves in an unbounded plasma. (auth)

33336 THEORY OF PARAMETRIC EXCITATION OF ELECTROSTATIC WAVES IN A FULLY IONIZED PLASMA. Zyunder, D.; Rukhadze, A. A. (Lebedev Inst. of Physics, Moscow). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 36-43(1971). (In Russian).

The parametric excitation of low-frequency and long-wave electrostatic oscillations in a fully ionized plasma placed in a weak uniform uhf field was investigated. The threshold values of the external field intensity corresponding to pumping of different modes are determined. Expressions are derived for the oscillation frequencies and increments near the thresholds. (auth)

33337 ANOMALOUS SKIN EFFECT OF MICROWAVES INCIDENT ON MAGNETOPLASMAS. Minami, Kazuo; Takeda, Susumu (Nagoya Univ., Japan). Phys. Rev. Lett.; 26: 614-16(15 Mar 1971).

The anomalous skin effect of microwaves is experimentally in-

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vestigated for a high-density gaseous plasma near the electron cyclotron resonance and is compared with a theoretical prediction. (auth)

33338 INSTABILITY OF PLASMA WITH CURRENT IN MAGNETIC FIELD. Sizonenko, V. L.; Stepanov, K. N. (Inst. of Physics and Technology, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: 438-45(Mar 1971). (In Russian).

Ion-cyclotron plasma oscillations with wavelength essentially less than the Larmor radius of ions ρ_i were excited by electrons drifting under the electric field effect along a magnetic field. It is shown that the frequency of such oscillations, which is within the range of $n\omega_{Hi} < \omega k < (n+1)\omega_{Hi}$, with $n \sim k\rho_i \gg 1$, can not be close to a multiple of the ion cyclotron frequency ω_{Hi} (k is a wave vector). This is why cyclotron damping of such oscillations is small and why they can be easily excited by drift electrons. (auth)

33339 INVESTIGATION OF SPECTRA OF PLASMA ION-CYCLOTRON OSCILLATIONS. Kaladze, T. D.; Lominadze, D. G.; Stepanov, K. N. (Tbilisi State Univ., USSR. Inst. of Physics and Technology, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: 469-73(Mar 1971). (In Russian).

The results of numerical calculation of a dispersion equation for low-pressure plasma ion-cyclotron oscillations ($4\pi n_0 T_{e,i}/H_0^2 \ll 1$) are presented for different values of the ratio of ion temperature T_i to electron temperature T_e and parameters $\beta = 4\pi n_0 T_i/H_0^2 \cos^2\Theta$ (n_0 is plasma density, Θ is an angle between the external magnetic field H_0 and wave vector.) (auth)

33340 SIGNAL-PROPAGATION STUDIES IN A LOW-DENSITY PLASMA. Proni, John R. Jr.; Doggett, Wesley O.; Bennett, Willard H. (North Carolina State Univ., Raleigh). Plasma Phys.; 13: 191-8(Mar 1971).

Initial studies with a novel plasma and antenna system for producing a large-volume, uniform, low-density, quiescent plasma in which ion acoustic and ballistic pulses can be launched, transmitted, multiply reflected, and analyzed without need for signal averaging or other signal-enhancing devices are reported. By proper impedance matching and applying balanced signals to a double-grided antenna, it was possible to observe the propagation of electron pulses. Two new phenomena are also reported: a bulk plasma response to changes in antenna potential, and a type of dynamic impedance matching in which the reflectivity of an antenna for ion ballistic pulses is affected by the applied signals. (auth) (UK)

33341 THEORY OF PLASMA TURBULENCE FOR STRONG WAVE–PARTICLE INTERACTION. Rudakov, L. I.; Tsytovich, V. N. (Inst. of Atomic Energy, Moscow. Lebedev Inst. of Physics, Moscow). Plasma Phys.; 13: 213-28(Mar 1971).

A perturbation theory is developed, which in first approximation considers the strong interaction between waves and particles near the resonance $\omega = kv$. There follows a useful prescription for the calculation of nonlinear interaction. It is shown in what limit the usual approximations of perturbation theory may be applied. The effects of strong wave–particle interaction reduce the nonlinear interactions, e.g., in the case of ion-sound turbulence the nonlinear interaction with electrons is shown to be always small compared to the quasi-linear interaction, and for the case of Langmuir turbulence the effects of strong interaction become important in the nonlinear interaction when the noise-level, w, is sufficiently high i.e., $w \geq nTkr_D$, where n is the density, T the temperature, k the characteristic wave number and r_D the Debye length. (auth) (UK)

33342 WAVE ABSORPTION IN A NONUNIFORMALLY MAGNETIZED PLASMA. Ferrari, L. A. (Queens Coll., New York). Plasma Phys.; 13: 257-8(Mar 1971).

In a recent communication (Kuckes, 1968) the fractional power absorbed at a region of electron cyclotron resonance was inferred from a measurement of reflected power in the feed transmission line. It is shown that since the plasma chamber acts as a multiple-mode waveguide in this experiment, the reflected power is not necessarily a good indicator of the fractional power absorbed via the cyclotron resonance mechanism. (auth) (UK)

33343 GENERATION OF ION-ACOUSTIC WAVES IN SPACE. Kotsarenko, N. Ya.; Yukhimuk, A. K. (Inst. of Geophysics, Kiev). Geomagn. Aeron. (USSR) (Engl. Transl.); 10: 704-6(1970).

Translated from Geomagn. Aeron.; 10: 893-4(1970).

The mechanism of generation of ion-acoustic oscillations under the effect of strong electromagnetic radiation is studied. Ion-acoustic waves in a nonisothermal plasma whose electron function is distorted by the presence of an external electromagnetic field is a specific example investigated. Some space objects with a high electromagnetic radiation energy density are examined and include quasars, the shells of supernovae, pulsars, and the outer corona of the Sun. (J.C.W.)

33344 MICROWAVE RESONANCE ABSORPTION IN PLASMA. Nandedkar, D. P.; Bhagavat, G. K. (Indian Inst. of Tech., Bombay). pp 255-60 of Proceedings of the Symposium on Electronics. Bombay; Dept. of Atomic Energy (1970).

From Symposium on electronics; Bombay, India (25 Feb 1970). See CONF-700221.

The plasma is considered as a weakly ionized gas with electrons, ions, and neutral molecules in thermal equilibrium. A uniform electric field is applied to the plasma. A theoretical analysis of the resonance microwave energy absorption by the plasma is given. (M.O.W.)

33345 GENERATION OF MICROWAVES UTILIZING HIGH-DENSITY PLASMA. Sen, S. N. (North Bengal Univ., Rajarammohanpur, India). pp 261-8 of Proceedings of the Symposium on Electronics. Bombay; Dept. of Atomic Energy (1970).

From Symposium on electronics; Bombay, India (25 Feb 1970). See CONF-700221.

Two methods for the amplification and generation of microwaves utilizing the high-density plasma are reviewed and the possibility of the practical application of the two methods is discussed. The first method uses fast electron beams. The second method uses the inertial property of the plasma for tuning a resonant cavity. (M.O.W.)

33346 MICROWAVE SCATTERING FROM UNSTABLE ELECTRON PLASMA WAVES. Arunasalam, V.; Heald, M. A.; Sinnis, J. (Princeton Univ., N. J.). Phys. Fluids; 14: No. 6, 1194-1203 (Jun 1971).

An analysis is presented of an experimental study of the scattering of microwaves by the density fluctuations due to electron plasma-wave instability in a beam–plasma system. Reasonably good agreement with the general predictions of the Shapiro and the Drummond and Pines nonlinear theories of plasma oscillations is obtained. In particular, at the "quasi-linear" steady state, the experimentally measured values of the scattering cross sections, the angular spread of the scattered radiations, the functional dependence of the scattering cross sections on the wavenumber of the most unstable plasma wave mode, and the increase in the thermal energy of the plasma electrons were all in reasonably good agreement with the corresponding theoretically expected values. In a few cases, a rather weak satellite line corresponding to scattering at the "bounce frequency" was seen. In these cases, the satellite line appeared only on the low-frequency side of the main plasma line. (auth)

33347 REFLECTION AND TRANSMISSION MEASUREMENTS ON A MAGNETIZED PLASMA SLAB. O'Brien, B. B.; Kuehl, H. H. (Univ. of Southern California, Los Angeles). Phys. Fluids; 14: No. 6, 1187-93(Jun 1971).

Experimental observations of microwave reflection from and transmission through a magnetized plasma slab are reported. The incident wave has a frequency below the second cyclotron harmonic and an electric field perpendicular to the static magnetic field. It is found that the reflection and transmission coefficients exhibit a resonant structure due to longitudinal wave resonances in the interior of the plasma. The observations are shown to be consistent with a theory based on the Pearson equations. (auth)

33348 MOTION OF CHARGED PARTICLES IN A CIRCULARLY POLARIZED WAVE PACKET. Laird, M. J. (King's Coll., London). Phys. Fluids; 14: No. 6, 1282-4(Jun 1971).

An integral is derived for the motion of a charged particle in a circularly polarized wave packet, propagating along a uniform magnetic field, and a longitudinal electric field. The integral may be used to reduce the order of the equations of motion. (auth)

33349 MEASUREMENTS OF THE DISPERSION RELATION FOR DRIFT WAVES IN A CESIUM PLASMA. Obiki, T.; Takahashi, N.; Itatani, R. (Nagoya Univ., Japan). Phys. Fluids; 14: No. 6, 1284-5(Jun 1971).

Dispersion curves of drift waves in a cesium plasma column obtained experimentally with the use of rotational electric fields show different characteristics from that of the slab model. (auth)

33350 THREE-WAVE INTERACTION AND NONLINEAR WAVE–PARTICLE SCATTERING. Krishan, S. (Univ. of Tennessee, Knoxville. Oak Ridge National Lab., Tenn. Univ. of Alberta, Edmonton); Fukai, J. Phys. Fluids; 14: No. 6, 1158-65(Jun 1971).

A study was made of three-wave interaction and nonlinear wave–particle scattering for waves propagating parallel to the external magnetic field using quantum techniques. The three-wave interaction refers to longitudinal, transverse, and Alfvén or whistler modes. The waves taking part in the nonlinear wave–particle scattering are transverse, Alfvén, and whistlers. Kinetic equations containing these effects are derived. It is established

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that the three-wave interaction for Alfvén or whistler modes is impossible. (auth)

33351 AMPLITUDE DISPERSION IN THE ELECTROMAGNETIC MODES. Selim, A. A. (Univ. of Alberta, Edmonton); Krishan, S. Phys. Fluids; 14: No. 6, 1166-70(Jun 1971).

Amplitude-dependent frequency shift for whistlers, Alfvén, and light waves is calculated. Unlike the previous work of this nature, which makes use of the Krylov–Bogoliubov–Mitropolskii method, the diagrammatic method of field theory is used. The result for light waves agrees closely with Tidman, but for whistler modes, it disagrees with Tam. (auth)

33352 EXACT NONLINEAR EVOLUTION OF ALFVEN MODES IN THE GUIDING-CENTER MODEL. Patterson, Blake (Univ. of California, Berkeley). Phys. Fluids; 14: No. 6, 1127-36(Jun 1971).

Alfvén waves parallel to a uniform magnetic field in a uniform but anisotropic plasma are studied in the Chew–Goldberger–Low and guiding-center models. Exact solutions are found in the stable and unstable cases. When the plasma is stable, an arbitrarily large constant amplitude perturbation perpendicular to the uniform field can propagate without distortion parallel to the uniform field. The exact nonlinear behavior of an unstable circularly polarized Alfvén mode is obtained: growth of a finite perturbation is quenched in a finite time, and decay begins immediately. (auth)

33353 PARAMETRIC AMPLIFICATION OF ALFVEN WAVES. Vahala, George; Montgomery, David (Univ. of Iowa, Iowa City). Phys. Fluids; 14: No. 6, 1137-40(Jun 1971).

A calculation describing the parametric amplification of Alfvén waves in a uniform, perfectly conducting, magnetohydrodynamic fluid is reported. The calculation was motivated by a recent experiment of Lehane and Paoloni. A magnetically supported uniform column of the magnetohydrodynamic fluid is imagined to be subjected to an externally imposed, sinusoidally varying, magnetic field which can be idealized as spatially uniform. It is shown that a certain class of Alfvén waves which have an axial wavelength long compared with the radius of the column can be parametrically amplified in the case where their frequency and the modulating frequency satisfy certain integer quotient relations. The mathematical behavior is determined by Mathieu equations. (auth)

33354 PENETRATION OF ELECTROMAGNETIC WAVES INTO PLASMA. Gupta, R. M.; Varma, N. L. (Univ. of Rajasthan, Jaipur, India). Acta Phys. Acad. Sci. Hung.; 29: No. 2-3, 229-37(1970).

Landau studied the longitudinal field penetration into a semi-bounded plasma considering specularly reflecting electrons at the boundary. Kurilko and Popov and then Gorman examined the same problem, considering a fraction "p" of all incident electrons reflecting specularly and the remaining portion diffusely. Lastly, Mason treated the same problem at length and gave solutions for specular and diffuse reflections. Here the problem of penetration of transverse electromagnetic waves into a semi-bounded plasma is formulated. Specular reflection of electrons is studied, and these results are used to discuss the anomalous skin effect. (auth)

33355 ANALYSIS OF HARMONICS GENERATED IN A WEAKLY IONIZED PLASMA. Jancel, Raymond (Univ., Paris). Compt. Rend., Ser. B; 272: No. 11, 657-60(15 Mar 1971). (In French).

A method for calculating the harmonics generated by a plane electromagnetic wave in a weakly ionized medium is proposed. (auth) (France)

Shielding

Refer also to abstracts 33936 and 34333.

33356 (ANS-SD-11) PROCEEDINGS OF SPECIAL SESSIONS ON NUCLEAR DATA FOR SHIELDING AND MULTIDIMENSIONAL SHIELDING CALCULATIONS. American Nuclear Society 1969 Winter Meeting, San Francisco, California, November 30–December 4, 1969. Huddleston, C. M. (comp.) (American Nuclear Society, Hinsdale, Ill.). 230p. (CONF-691133).

Nine papers are included and separate abstracts were prepared for seven. The other two have already appeared in NSA; see NSA 24: 6580 and 18405. (M.H.R.)

For abstracts of individual papers see: 33357–33363.

33357 (ANS-SD-11, Paper 1) THRUST OF CROSS-SECTION DATA REQUIREMENTS FOR REACTOR SHIELDING CALCULATIONS. Penny, S. K. (Oak Ridge National Lab., Tenn.). 19p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

The increasing stringency in the requirements for cross-section data necessary to perform radiation shielding calculations is emphasized. Some reasons given for this are: recently acquired capabilities of calculating penetration to large depths, of efficiently handling large arrays of cross-section data, and of performing coupled neutron and gamma-ray transport calculations. The methods for measuring radiation energy spectra, angular distributions, and other quantities have been improved recently. The dilemma involved in using measurement data alone or calculations alone is discussed. Efforts to tie model calculations and measurements of cross sections together are mentioned. Data sets illustrating all of these points are given. (M.H.R.)

33358 (ANS-SD-11, Paper 3) NUCLEAR DATA GENERATION AND ANALYSIS FOR SHIELDING APPLICATIONS. Yost, K. J. (Oak Ridge National Lab., Tenn.). 17p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

The nuclear models and theories for cross-section generation and evaluation are discussed briefly. The use of the extended R-matrix theory is discussed as a practical method of incorporating energy levels and wave functions generated by the microscopic nuclear structure models into cross-section calculations. (M.H.R.)

33359 (ANS-SD-11, Paper 5) MEASUREMENTS OF NUCLEAR DATA FOR SHIELDING USING A LINAC. Orphan, V. J. (Gulf General Atomic, Inc., San Diego, Calif.). 47p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

Three experimental techniques are briefly described, and samples of data obtained are presented. The techniques are: high-resolution total cross-section measurements, measurement of resonance neutron capture γ-ray spectra and yields, and measurement of γ-ray production cross sections for $(n,x\gamma)$ reactions. The first experiment illustrates the precision currently possible in the measurement of total cross sections. The second and third experiments are examples of recently developed techniques that may be used to measure γ-ray production cross sections from thermal neutron energies up to 15 MeV. (M.H.R.)

33360 (ANS-SD-11, Paper 6) MORSE MONTE CARLO CODE AND ITS APPLICATIONS. Cain, V. R.; Stevens, P. N.; Straker, E. A. ([Oak Ridge National Lab., Tenn.]). 14p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

The MORSE (Multigroup Oak Ridge Stochastic Experiment) code is described, and its advantages are discussed. It is a multipurpose neutron and gamma-ray Monte Carlo code for shielding problems. Examples of results from several benchmark problems used during the development of the code to check out various features are presented. (M.H.R.)

33361 (ANS-SD-11, Paper 7) KERNEL METHODS FOR RADIATION SHIELDING CALCULATIONS. Trubey, D. K. (Oak Ridge National Lab., Tenn.). 54p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

Development and use of kernel methods in solving problems of radiation shield design and radiation transport are reviewed. Two classes of kernels are identified: empirical and computational. An analysis of the various techniques is made, and examples are given. The relevant computer codes in the collection of the Radiation Shielding Information Center are listed and briefly described. It is concluded that kernel methods are valuable for quick estimates, hand calculations, checks of transport computer code results, and engineering parameter studies. However, the method can give underestimates for situations that the applied kernel cannot treat properly. (auth)

33362 (ANS-SD-11, Paper 8) PRACTICAL ASPECTS OF MULTI-DIMENSIONAL MONTE CARLO SHIELDING CALCULATIONS. Mittelman, Phillip S.; Kalos, Malvin H. (Mathematical Applications Group, Inc., White Plains, N. Y.). 20p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

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In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

Some of the practical problems in using multidimensional Monte Carlo programs are reviewed, and some suggestions for solving these problems are given. It is pointed out how theoretical developments, now in progress, may eliminate the majority of the difficulties standing in the way of the routine use of multi-dimensional Monte Carlo programs. (M.H.R.)

33363 (ANS-SD-11, Paper 9) ADVANCED MONTE CARLO CONCEPTS: METHODS AND APPLICATIONS. Jordan, Thomas M. (A. R. T. Research Corp., Los Angeles, Calif.). 22p.

From Conference on nuclear data for shielding and multidimensional shielding calculations; San Francisco, Calif. (30 Nov 1969).

In Proceedings of special sessions on nuclear data for shielding and multidimensional shielding calculations.

Flux at a point represents the most useful solution to the transport equation in complex geometries. Several Monte Carlo concepts that arise in obtaining accurate point fluxes are described. These concepts include random sampling of source distributions biased by point-to-point kernel approximations of importance. The use of analytic techniques whenever possible is also discussed, with emphasis on the use of energy-dependent samples. (auth)

33364 (CONF-710107) SECOND CONFERENCE ON TRANSPORT THEORY, JANUARY 26–29, 1971. (Los Alamos Scientific Lab., N. Mex.). Apr 1971. 659p. Dep. NTIS.

Twenty-six papers are included. Separate abstracts were prepared for twenty-five. (M.H.R.)

For abstracts of individual papers see: 33365–33389.

33365 (CONF-710107–, pp 1-49) TRANSPORT EQUATIONS FOR DENSE, MANY-PARTICLE SYSTEMS. Duderstadt, James J. (Michigan Univ., Ann Arbor. Dept. of Nuclear Engineering).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The transport of particles in dense systems such as liquids and plasmas is discussed from the viewpoint of kinetic theory. Several of the more prominent approaches for obtaining transport equations (kinetic equations) for such processes are reviewed. Particular attention is focused upon the use of projection operator techniques to obtain kinetic equations for both the particle distribution function $f(\vec{r},\vec{p},t)$ and for time correlation functions. As an illustration of such methods, these equations are applied to the calculation of density and current correlation functions in simple, classical liquids. (auth)

33366 (CONF-710107–, pp 50-82) KINETIC THEORY OF DENSITY CORRELATION FUNCTIONS. Yip, Sidney (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Time-dependent density correlation function in dilute gases is calculated as an initial-value problem based on the linearized Boltzmann equation. When viewed in the context of linear response theory, the formulation is seen to be a particular application of the fluctuation-dissipation theorem. The method of kinetic models is used to obtain results for rigid spheres and Maxwell molecules ($1/r^4$ repulsive potential) which are valid at any ratio of wavelength to mean free path. The results have a direct application in Rayleigh scattering experiments so that recent laser measurements provide a test of the Boltzmann equation in the kinetic regime. (auth)

33367 (CONF-710107–, pp 83-95) SLOWING DOWN WITH INELASTIC SCATTERING. Corngold, Noel; Yan, Cheng-Chih (California Inst. of Tech., Pasadena).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The easiest, nontrivial model is chosen. It is assumed that: the moderator atoms are motionless and in their ground-states; the nuclear elastic and inelastic scatterings are uncorrelated; the nucleus has but a single excited level; and the nucleus is very heavy. In both the elastic and inelastic scatterings only the leading term is retained. Nuclear events other than scattering is ignored; the elastic scattering is taken to be independent of neutron energy. The block of moderator is large enough, and the source smooth enough that the problem may be taken as space-independent. Some of the results obtained are described. They are limited to the steady-state problems. (M.H.R.)

33368 (CONF-710107–, pp 96-114) HILBERT'S PARADOX AND LOW FREQUENCY SOLUTIONS OF NON-DEGENERATE BOLTZMANN EQUATIONS. Thurber, J. K. (Purdue Univ., Lafayette, Ind.); Nicolaenko, B. (New York Univ., N. Y.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The linearized classical gas-kinetic hard-sphere Boltzmann equation and a related family of Boltzmann equations is investigated. Rigorous dispersion laws and fundamental solutions are derived in terms of which the Chapman–Enskog expansion is shown to converge, not in general to a solution of the Boltzmann equation, but rather to an asymptotic solution. The related Hilbert paradox is resolved, and a question raised by Grad as to the existence of dispersion laws is answered. (auth)

33369 (CONF-710107–, pp 115-35) ANALYTIC CONTINUATION AND HIGH FREQUENCY SOLUTIONS OF NON-DEGENERATE BOLTZMANN EQUATIONS. Nicolaenko, B. (New York Univ., N. Y.); Thurber, J. K. (Purdue Univ., Lafayette, Inc.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The intermediate- and high-frequency fundamental solutions of a family of Boltzmann equations with nondegenerate, anisotropic scattering kernels are investigated. These systems of integral equations are analytically continued into the continuous spectrum of the classical gas-kinetic Boltzmann equation, and the resulting spectral concentrations are located asymptotically. Comparison is made with the model equation approach. (auth)

33370 (CONF-710107–, pp 136-49) ON MULTIGROUP TRANSPORT THEORY WITH A DEGENERATE TRANSFER KERNEL. Silvennoinen, Pekka; Zweifel, P. F. (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

A one-dimensional, time-independent transport equation in N groups is considered. The transfer kernel is taken to be degenerate. Full-range bi-orthogonality of the Case eigenfunctions is shown. It holds even for a nondegenerate kernel. The Case eigenfunctions are complete on the full range if any of certain given conditions holds. Conditions for half-range completeness are discussed. (M.H.R.)

33371 (CONF-710107–, pp 150-97) ANALYTIC METHODS IN THREE-DIMENSIONAL TRANSPORT THEORY. Abu-Shumays, I. K. (Argonne National Lab., Ill.); Bareiss, E. H. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

There are two main approaches to analytical transport theory, the so-called normal mode expansion method, and the method of integral transformations. These methods are not completely distinct. It is indicated here how generating functions can be used to derive a set of elementary solutions based on the normal-mode expansion method for the homogeneous monoenergetic stationary transport equation. It is shown that the method of integral transformations can be utilized to yield the expansion coefficients for the representation of the flux or the angular distribution in terms of normal-mode solutions. The powerful method of Green's function for solving boundary-value problems is regarded as belonging to either of the above approaches, depending on which method is used to determine the flux or angular distribution due to a (monodirectional) point source. The usefulness of individual analytic solutions for establishing benchmark problems for computer codes, or for developing new approximation techniques, is indicated. (auth)

33372 (CONF-710107–, pp 198-210) SPHERICAL HARMONICS AND LEGENDRE POLYNOMIALS. Abu-Shumays, I. K. (Argonne National Lab., Ill.); Bareiss, E. H. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Surface harmonics are introduced in a simple way as expansion terms for an arbitrary function over the surface of a unit sphere. A number of useful properties of surface and solid harmonics, including transforms based on generating function techniques, are derived, relying only on known properties of Legendre polynomials. (auth)

33373 (CONF-710107–, pp 211-57) NUMERICAL APPROACHES TO THE TRANSPORT EQUATION AND COMPUTATIONAL EXPERIMENTATION. Bareiss, Erwin (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.).

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From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

It is shown that the variational methods to solve the transport equation have a proven history. In special cases, they are equivalent to certain discrete-ordinate methods. No single functional yields the best variational approximation method for all transport problems. A tenet in numerical analysis is that the best numerical procedures are obtained when good use of the inherent special properties of operators is made. The transport equation has the special feature of providing the derivatives in the direction of neutron flow. This property was used to reduce the storage requirement for flux information mainly to points on the physical interfaces that describe the geometrical configurations of a reactor. It was shown that direct inversion methods can often be substituted for iterative methods with substantial gain in time saving. There is an optimal approximation that balances the errors in space and angular directions (numerical transport paradox). A general computational procedure was proposed that has basic advantages over the discrete-ordinate method. By applying variational principles on the basic procedure, an individually designed optimal answer to a given problem can be obtained, therefore generalizing the ideas of the original flexible transport theory routines. In addition, the numerical transport paradox was resolved, and the way to eliminate the ray effect is shown. The analysis of this approach is a departure from the classical $O(h^k)$ techniques and is based on the Weierstrass approximation theorem. The principles developed here are independent of the form of the transport equation. (M.H.R.)

33374 (CONF-710107–, pp 258-85) APPLICATION OF FINITE ELEMENT TECHNIQUES FOR THE NUMERICAL SOLUTION OF THE NEUTRON TRANSPORT AND DIFFUSION EQUATIONS. Kaper, Hans G.; Leaf, Gary K.; Lindeman, Arthur J. (Argonne National Lab., Ill.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

A technique for developing high-order approximation procedures for the numerical solution of the equations of neutron transport and diffusion is described. First, it is shown that the neutron transport equation can be transformed into a self-adjoint equation. Then, the problem of solving the transport and diffusion equations is formulated as a problem of variational calculus. For both equations, the variational principle is based on the minimization of a functional that is quadratic and positive-definite. The finite-element method provides a technique for the approximate solution of these minimization problems. (auth)

33375 (CONF-710107–, pp 286-304) SOLUBLE BOUNDARY VALUE PROBLEMS OF TRANSPORT THEORY. Case, K. M. (Rockefeller Univ., New York).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Closed-form solutions of the linearized transport equation are discussed. The application of the theory of several complex variables is discussed briefly. The application of the theory of generalized analytic functions is considered. The soluble problems are surveyed. When a problem is soluble and when it will not be is shown. An attempt is made to verify the contention that the Fourier transform and the Wiener–Hopf decomposition are still the most powerful and useful techniques for these problems. (M.H.R.)

33376 (CONF-710107–, pp 305-24) TWO-DIMENSIONAL PROBLEMS IN INTEGRAL TRANSPORT THEORY. Erdmann, R. C.; Sanchez, J. (California Univ., Los Angeles. School of Engineering and Applied Science).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Some work in two-dimensional neutron transport theory is reviewed. Only the integral transport equation in the transformed domain is dealt with. The quarter-space problem is defined, the Fourier transformations are carried out, and several possible approaches toward a solution are discussed briefly. An iteration scheme is presented that could provide some semblance of an answer to the quarter-space problem. A variation for solving two-dimensional singular integral equations is sketched, where a certain class of two-dimensional problems is reduced to a one-dimensional one whose solution is apparent. In applying this to the transformed transport equation, however, a gap is found in its utility due to a problem in analyticity domains for one of the coefficients. Neglecting the difficulties with the quarter space, the wedge problem in transport theory is discussed briefly. (M.H.R.)

33377 (CONF-710107–, pp 325-47) FURTHER RESULTS FOR THE SYMMETRIC QUARTER SPACE MILNE'S PROBLEM. Lam, S. K.; Leonard, A. (Stanford Univ., Calif. Nuclear Engineering Div.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Double Fourier transformation and extensive use of contour integration in two complex variables are used to determine a family of solutions to the Milne problem for the quarter space. A simplified representation of the asymptotic particle density and the correction terms near the corner are determined. Numerical calculations for a symmetric source distribution at infinity are presented. (auth)

33378 (CONF-710107–, pp 348-90) MORE PRECISE DEFINITION OF THE DISCRETE ORDINATES METHOD. Carlson, Bengt G. (Los Alamos Scientific Lab., N. Mex.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The discrete ordinates method is often used for obtaining solutions to the transport equation. In finite-difference formulation, it is generally referred to as the discrete S_n method, or simply as S_n. In defining it, the following two main principles are involved: (1) Discretization of the directional, or angular, variable by means of a quadrature set constructed on the surface of a unit sphere. The order of discretization, implying order of accuracy, is denoted by n. (2) Correlation of the discrete ordinates equations with the moments equations, the latter obtained by the method of (angular) moments, in order to achieve more precise definition and to improve accuracy for a given n. Topics discussed are: the unit sphere quadrature, symmetric quadrature sets, correlation of quadrature sets and angular moments, the determination of curvature terms, the derivation of anti-ray-effect corrections, and modified diffusion theory and variable quadrature S_n. (M.H.R.)

33379 (CONF-710107–, pp 391-425) EFFECTIVENESS OF ACCELERATION TECHNIQUES FOR ITERATIVE METHODS IN TRANSPORT THEORY. Reed, Wm. H. (Los Alamos Scientific Lab., N. Mex.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The effectiveness of the acceleration techniques known as coarse-mesh rebalance and the synthetic method is examined for the iterative processes of transport codes. These two methods are shown to be equivalent in a certain sense. Analysis is presented in homogeneous-slab geometry, which predicts the convergence or divergence of the synthetic method. Stable versions of these methods are developed, and numerical results comparing their effectiveness with that of Chebychev acceleration are presented. (auth)

33380 (CONF-710107–, pp 426-63) MULTI-GROUP TRANSPORT THEORY. Bowden, R. L.; McCrosson, F. J. (Virginia Polytechnic Inst., Blacksburg. Dept. of Physics).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

A new method to analyze multigroup transport problems, which avoids completeness theorems, is presented. The method consists of extending the angle variable to the complex plane and transforming the integro-differential form of the transport equation into a functional equation and corresponding singular integral equation for the neutron flux in which the spatial variable enters only as a parameter. The general solution to the equations is obtained in terms of an arbitrary vector function contained in the equations and whose form is obtained by appropriate boundary conditions. Determination of the form of this arbitrary vector function is illustrated by analyzing the Milne and critical problems. (auth)

33381 (CONF-710107–, pp 464-88) TRANSPORT-THEORY SLAB ALBEDO-PROBLEM. Gibbs, Alan G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The boundary-value problem for a finite slab with neutrons incident on both faces is considered from the viewpoint of singular eigenfunction expansions. The boundary conditions lead to a pair of dual singular integral equations for the expansion coefficients, and these are recast in the form of a (2×2) matrix Hilbert problem. An explicit solution is obtained in terms of the X and Y functions. The resulting expression for the expansion coefficients

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has the form of a general orthogonality relation for the eigenfunctions, which reduces to the full-range and half-range relations as the slab thickness approaches zero, or infinity, respectively. Thus, a mathematical structure common to albedo problems for slabs of all thicknesses is obtained, and the underlying relationship between the invariant-imbedding and eigenfunction-expansion methods is further illuminated. (auth)

33382 (CONF-710107–, pp 489-517) TRANSPORT PROBLEMS IN MEDIA WITH PERIODIC STRUCTURE. Allen, Richard C. Jr.; Wing, G. Milton (New Mexico Univ., Albuquerque).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The problem of transport of particles in a slab geometry is considered, the unique feature being that the slab is assumed to have a periodic structure. It is shown that the particle density at any point in the slab can be obtained numerically by integrating a set of differential equations of initial-value type over one period, followed by the use of certain relatively easy-difference and functional equations. There are strong indications that considerable advantage is gained in time, accuracy, stability, etc. over the standard method of handling such problems. Several rather simple numerical examples are given. Agreement with results obtained in other ways is excellent. It is noted that the algorithm produced is really applicable to a wide class of two-point boundary-value problems having little or nothing to do with transport theory per se. (auth)

33383 (CONF-710107–, pp 519-32) SOME PROBLEMS IN TIME-DEPENDENT TRANSPORT THEORY. Hendry, W. L. (Los Alamos Scientific Lab., N. Mex.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Systems that are below prompt-critical are considered, and the linear time-dependent neutron transport equation is studied in a quite general setting. Both source and cross sections are allowed to depend on time. The method of matched asymptotic expansions is used to find an asymptotic solution that is uniformly valid in time. This solution is written in the form of a sum of solutions to simpler problems and, for most practical problems, will be essentially exact. After a short initial time period, the transport equation may be solved at a given time by a single inversion of the steady-state transport operator, i.e., with a steady-state code. (auth)

33384 (CONF-710107–, pp 533-50) SOME TRANSFER MATRIX CALCULATIONS FOR POLARIZED LIGHT. Aronson, R. (New York Univ., N. Y.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Some results on radiative transfer in atmospheres in which molecular scattering is the dominant effect are presented. A model in which polarized light is scattered by a combination of Rayleigh and depolarized isotropic scattering is considered. In addition, the presence of an absorbing component in the atmosphere is permitted. This model does not apply when most of the scattering is by dust particles. In that case, Mie scattering is dominant. The transfer matrix method is used for these calculations. In numerical computations it was found convenient to use a double-P_N approximation. Extensive computations of reflection and transmission matrices in a double P_{16} approximation were made. The results presented are for CO_2, which is the prime constituent of the atmosphere of Venus. The reflected and transmitted angular fluxes and degree of polarization for a beam incident almost normally on a 1 mfp-thick atmosphere are tabulated. Results for an atmosphere 8 mfp thick and flux reflected from a half-space are presented. (M.H.R.)

33385 (CONF-710107–, pp 551-66) HALF-RANGE EXPANSION THEOREMS IN STUDIES OF POLARIZED LIGHT. Burniston, E. E.; Siewert, C. E. (North Carolina State Univ., Raleigh).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The established normal modes of the vector equation of transfer describing the transport of polarized light are used to construct solutions to typical half-space problems. The half-range completeness theorem required by this method is discussed in the context of systems of singular integral equations. Although the Riemann–Hilbert problem encountered here is defined in terms of continuous rather than Hölder continuous functions, the existence of a canonical solution is established, and the developed properties of this canonical matrix are used to complete the proof of the necessary half-range expansion theorem. (auth)

33386 (CONF-710107–, pp 567-77) RADIATIVE TRANSFER WITH PARTIALLY COHERENT SCATTERING. Hemsch, Michael J.; Ferziger, Joel M. (Stanford Univ., Calif. Dept. of Mechanical Engineering).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The Boltzmann equation for a gas which scatters radiation partially coherently and partially by total redistribution is treated. The eigenfunctions are found, and full-range completeness is proved. A discussion of half-range problems is also given. (auth)

33387 (CONF-710107–, pp 578-91) SOME RECENT DEVELOPMENTS IN COMPUTATIONAL RADIATIVE TRANSFER. Hunt, G. E. (Jet Propulsion Lab., Pasadena, Calif.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The problem of analyzing the transfer of radiation through a cloudy planetary atmosphere is considered. From a mathematical point of view solving the equation of transfer is of interest and the recent developments in this area are reviewed briefly. The value of these mathematical techniques and the present state of the art are assessed through the eyes of an experimentalist, who is concerned with practical problems. (auth)

33388 (CONF-710107–, pp 592-623) TRANSFER OF POLARIZED LIGHT IN RAYLEIGH-SCATTERING HALF SPACES WITH TRUE ABSORPTION. Schantz, T. W.; Siewert, C. E. (North Carolina State Univ., Raleigh. Dept. of Nuclear Engineering).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

The singular-eigenfunction-expansion technique, often employed for studies in neutron transport theory, is used to introduce a general solution to the vector equation of transfer describing the transport of polarized light in a Rayleigh-scattering atmosphere with true absorption (imperfect scattering). Two discrete eigenvectors and two linearly independent, degenerate, continuum eigenvectors are presented and form the basis for subsequent analysis, which is directed primarily toward the construction of solutions to typical half-space problems. The eigenvectors are used to establish a singular integral equation and a linear integral constraint necessary and sufficient to specify the required $\underline{\underline{H}}$-matrix, a generalization of Chandrasekhar's H-function. Further, the analysis yields the nonlinear integral equation, previously derived from the classical principles of invariance; this nonlinear equation and the linear constraint are also shown to be sufficient to specify the $\underline{\underline{H}}$-matrix and are used for computational purposes. After the general formalism is established, the method is used to construct complete solutions (valid at any optical depth) to the half-space albedo problem and the classical Milne problem. These solutions are written explicitly in terms of the normal modes, and all unknown expansion coefficients are then expressed in terms of the $\underline{\underline{H}}$-matrix. To illustrate the computational merits of the analysis, highly accurate numerical results for the half-space albedo, and the Milne-problem extrapolated end point are presented for a representative set of values of the single-scatter albedo. (auth)

33389 (CONF-710107–, pp 624-54) APPLICATION OF AN OPERATOR FORMALISM AND THE GENERALIZED NEWTON–RAPHSON METHOD IN RADIATIVE TRANSFER. Skumanich, A. (High Altitude Observatory, Boulder, Colo.).

From second conference on transport theory; Los Alamos, N. Mex. (26 Jan 1971).

In second conference on transport theory, January 26–29, 1971.

Simultaneous equations for the determination of the ionization equilibrium of an optically thick self-excited plasma and the density of the resulting nongray recombination radiation are reduced to a single nonlinear (integral) operator equation for the ionization state occupation index. Several sources of nonlinearity occur: (1) radiation operators that appear are nonlinear through the dependence of the opacity and stimulated emission terms on the ionization state, and (2) the collisional rate coefficients are nonlinear through the dependence of the electron density on the ionization state. An operator perturbation scheme, based on the generalized Newton–Raphson method, is developed and is used to obtain an iterative solution of the operator equation for a two-state system (the simple free-bound problem). (auth)

33390 (COO–2060-10) APPLICATION OF THE MATRIX EXPONENTIAL KERNEL. Rohach, Alfred F. (Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.). Feb 1971. 11p. (CONF-710304–10; ERI–97600). Dep. NTIS.

From Symposium on natural and manmade radiation in space; Las Vegas, Nev. (1 Mar 1971).

A point matrix kernel for radiation transport, developed by the transmission matrix method, has been used to develop buildup factors and energy spectra through slab layers of different materials for a point isotropic source. Combinations of lead/water slabs were chosen for examples because of the extreme differences in shielding properties of these two materials. (auth)

33391 (EGG-1183-1468) EXPERIMENTAL SUPPORT FOR THEORETICAL COHERENT X-RAY SCATTERING FACTORS. Tech Report No. L-978. Singman, Leif V. (EG and G, Inc., Los Alamos, N. Mex.). 2 Mar 1970. 19p. Dep. NTIS.

Theoretical coherent x-ray scattering factors have been found to be supported by experimental data. First, the success of x-ray crystal structure analysis would not have been possible without reliable atomic scattering factors calculated from theory. Second, a considerable number of experimental determinations of atomic scattering factor curves has been made, some having very close agreement with theory. (auth)

33392 (LA-4646) DISCRETE ORDINATES TREATMENT OF INDUCED SCATTERING. Lathrop, K. D. (Los Alamos Scientific Lab., N. Mex.). Feb 1971. Contract W-7405-eng-36. 5p. Dep. NTIS.

A transport equation including nonlinear induced scattering effects is written for the photon flux (speed of light times the density). A finite Legendre polynomial expansion is used to represent the scattering transfer probability (differential cross section). A multigroup formulation is derived with appropriate definitions of multigroup coefficients. Treatment of the induced scattering terms (including iterative strategy) in standard discrete ordinates programs is outlined. (auth)

33393 (ORNL-tr-2463) CALCULATION OF THE SPECTRA AND ABSORBED DOSES BEHIND A SHIELD PRODUCED BY THE ELECTRONS OF THE EARTH'S RADIATION BELT. Akkerman, A. F.; Beskrovnyi, I. M.; Nikitushev, Yu. M. Translated for Oak Ridge National Lab., Tenn., from Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 6: 64-71(1968). 9p. Dep. NTIS.

Using the Monte Carlo method, the transmission coefficients and the dose behind a shield due to electrons of the Earth's outer radiation belt were calculated both for a monatomic material and for a complex organic material. Perpendicular, as well as isotropic, incidence was considered. A comparison of the results of the calculations with those obtained by the method of the range-energy relation revealed that the latter results in a systematic overestimate of the dose behind the shield. The doses behind the shield produced by secondary radiation produced during electron transmission through the shield are estimated. (auth)

33394 (ORNL-tr-2464) MONTE CARLO PROGRAM FOR PHOTON AND ELECTRON TRANSPORT CALCULATIONS. Sugiyama, Haruo. Translated for Oak Ridge National Lab., Tenn., from Denki Shikensho Iho; 34: 126-40(1970). 25p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 45305. (M.O.W.)

33395 PAIR CROSS SECTIONS OF GAMMA RAYS. Rama Rao, J.; Murty, M. Sriramachandra; Premchand, K.; Parthasaradhi, K. (Andhra Univ., Waltair, India). Indian J. Pure Appl. P Phys.; 8: 670-1(Oct 1970).

Experimental values of pair cross sections of gamma rays (energy 1 to 2 MeV) of four radioactive sources reported earlier (Rama Rao, J., et al, Indian J. Pure Appl. Phys., 1: 199 (1963)) are compared with the theoretically evaluated values reported by Overbo et. al., (Phys. Rev., 175: 1978 (1968)). Although a general agreement is noticed between the theoretical and experimental values, significant deviations are observed very near the threshold (1.119 MeV) level. (auth)

33396 ABSORPTION OF COMPLEX γ-RADIATION IN MULTICOMPONENT MEDIA UNDER CONDITIONS OF GOOD GEOMETRY. Velysus, L. M. Sb. Nauch. Tr., Magnitogorsk. Gornomet. Inst.; No. 45, 61-3(1968). (In Russian).

Based on the law of absorption for a narrow monoenergetic beam of γ rays, $(I/I_0 = \exp[-\mu(E)h])$, a formula is set forth explaining the absorption of γ rays of a complex in polycomponent media under conditions of good geometry at a beam energy of $\leq$1.02 MeV. The expression for the intensity of the beam passing through a medium consists of two terms, taking into account the absorption of continuous and discrete spectra separately. The absorption of γ rays from ^{75}Se (discrete spectrum) in a 3-component medium of Pb-Cu-S was studied. (Referativnyi Zh.)

33397 EFFECTIVE ATOMIC NUMBERS FOR PHOTOELECTRIC PROCESS OF GAMMA RAYS. Rao, V. Seshagiri; Parthasaradhi, K. (Andhra Univ., Waltair, India). Sci. Cult. (Calcutta); 36: 572(Oct 1970).

The validity of an expression for calculating the effective atomic numbers for the gamma-ray photoelectric process is tested, using experimental data in alloys composed of varying Z elements from P to Pb. It is shown that there is satisfactory agreement between theoretical and experimental values within the range of errors. (M.H.R.)

33398 ABSOLUTE CROSS-SECTION MEASUREMENT OF THE ELEMENTARY PROCESS OF BREMSSTRAHLUNG PRODUCTION FOR GOLD AT 300 keV. Kreuzer, K.; Nakel, W. (Univ., Tuebingen, Ger.). Phys. Lett.; 34A: 407-8(19 Apr 1971).

The absolute cross section of 300-keV electron bremsstrahlung, differential with respect to the photon energy and to the photon and electron emission angles, was measured by using a coincidence technique. Furthermore, the disturbance of this elementary process by plural scattering was studied. (auth)

33399 ATTENUATION OF MONOENERGETIC NEUTRONS IN THE VARIOUS SHIELDING MATERIALS. Yoo, Young Soo (Atomic Energy Research Inst., Seoul). New Phys. (S. Korea); 10: 157-64(Dec 1970). (In Korean).

The attenuation of neutrons in various shielding materials such as water, paraffin, borated paraffin, lead, iron, and ordinary and heavy concrete, was studied. To determine the minimum thickness of shielding required for a neutron generator, the absorption characteristics of various materials were measured for neutrons produced through the T(p,n)^{3}He, D(d,n)^{3}He, T(d,n)^{4}He, and ^{9}Be(d,n)^{10}B reaction at the Van de Graaff accelerator (High Voltage Engineering, Type AN 400). Since the shielding is required for the protection of the operating personnel, the quantity of interest is the dose equivalent. This quantity was measured with the Rem Counter (20th Century Co. Type NRC III) for various shielding materials as a function of the absorber thickness. Except for 14.1 MeV, the neutron beam was collimated with a water tank collimator and irradiated fields were about 60 cm ϕ at the front surface of the neutron detector. Attenuation data are given for above shielding materials in connection with neutron energies 0.5, 1, 2, 5, 14.1, and 18 MeV, respectively. (auth)

33400 AVAILABLE COMPUTER CODES FOR RADIATION SHIELDING CALCULATIONS IN JAPAN. Takeuchi, Kiyoshi (Ship Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 13: 201-8(Apr 1971). (In Japanese).

The computer codes for radiation shielding calculations available today in Japan are listed. These computer codes were applied to various calculations of shielding design and shielding analyses for neutrons and gammas. The codes are listed in the form of a table, classified according to calculational methods, such as kernel, removal-diffusion, diffusion theory, Monte Carlo, numerical integration of the transport equation, invariant imbedding, multiple scattering, and ray analysis. (auth)

33401 PLURAL AND MULTIPLE SCATTERING OF LOW-ENERGY HEAVY PARTICLES IN SOLIDS. Meyer, L. (Humbolt Univ., Berlin). Phys. Status Solidi (b); 44: No. 1, 253-68 (1 Mar 1971).

Small-angle mutliple scattering of low-energy heavy particles (Born parameter $\alpha > 1$) in solid layers is calculated, using a scattering cross section derived from classical mechanics. The angular distribution of the scattered particles is given as a sum of two functions, which are tabulated. The calculated distributions coincide with those of the well-known theory of Moliere for large thicknesses of material. For small thicknesses there are profound deviations. (auth)

Solid-State Physics

33402 (ORNL-4669) SOLID STATE DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1970. (Oak Ridge National Lab., Tenn.). Mar 1971. Contract W-7405-eng-26. 117p. Dep. NTIS.

Research is reported in the following areas: optical properties, electronic structure, and band theory; magnetic resonance; magnetic properties; lattice dynamics; low-temperature properties; radiation damage; surface studies, diffraction, and channeling; research materials; and experimental equipment and new techniques. (D.L.C.)

Radiation Effects

Refer also to abstract 32763.

33403 (CEA-CONF-1745) PHONON SCATTERING AND INDUCED-ENERGY LEVELS IN ELECTRON-IRRADIATED Sb-DOPED Ge IN THE n to p-TYPE CONVERSION REGION. Laurence, G.; Albany, H. J. (Commissariat a l'Energie Atomique,

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Saclay (France). Centre d'Etudes Nucleaires). [1970]. 14p. (CONF-700824-2). Dep. NTIS (U. S. Sales Only).

From International conference on radiation effects and semiconductors; Albany, N. Y. (24 Aug 1970).

Low-temperature thermal-conductivity measurements on Sb-doped Ge, irradiated at ~40°C with 4-MeV electrons, are reported. The change in K with electron dose ϕ was investigated in the n- to p-type conversion region of two Sb concentrations (8.4×10^{15} and 4.5×10^{17} cm^{-3}). The thermal-conductivity behavior was shown to arise from electron–phonon scattering in relation to the antimony levels, irradiation-induced energy levels, and their charge states. Hall-effect measurements made at the different stages observed in the K variation indicate the dominant effects of the induced levels. The existence of a residual scattering near the n–p transition is a striking feature that might indicate the particular role or structure of the acceptor centers in this region. (auth) (France)

33404 (GIPR-50) TRANSMISSION AND RADIATION DAMAGE PHENOMENA IN ION BOMBARDMENT OF THIN FOILS. Hoegberg, G. (Chalmers Tekniska Hogskola, Goteborg (Sweden). Instiutionen for Fysik). Dec 1970. 26p. Dep. NTIS (U. S. Sales Only).

Experimental work carried out during the period 1966–1970 is summarized. The thesis is based on seven earlier published papers dealing with ion transmission through carbon foils and through crystalline gold foils, as well as radiation damage in gold crystals by ion bombardment. Experimental arrangements are briefly described. (Sweden)

33405 (IAE-2002) "KRISTALL" PROGRAM FOR STUDYING DYNAMICS OF RADIATION DAMAGE IN CRYSTAL LATTICES. Knizhnikov, Yu. N. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 44p. (In Russian). Dep. NTIS (U. S. Sales Only).

This monograph contains a study of the basic principles of writing an all-purpose computer program to simulate processes in crystal lattices of various types (face-centered cubic, body-centered cubic, and diamond), considering the thermal vibrations of the atoms. Results of "computer experiments" are presented as examples of use of the program, including experiments for the silicon lattice. The establishment of thermodynamic equilibrium in a crystal lattice and the process of transition to the molten state are also simulated. (JPRS)

33406 (JINR-P1-5682) MEASUREMENT OF THE LIGHT YIELD OF THE CsI(Tl) CRYSTAL BOMBARDED WITH THE PROTONS, DEUTERONS, AND TRITONS IN THE ENERGY REGION 15 TO 100 MeV. Budyashov, Yu. G.; Zinov, V. G.; Konin, A. D.; Mukhin, A. I.; Chatrchyan, A. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 6p. (In Russian). Dep. NTIS (U. S. Sales Only).

It is shown that, within measurement errors, the light yield of the CsI(Tl) crystal bombarded with protons, deuterons, and tritons in the energy region 15 to 100 MeV is equal and depends linearly on the energy. (auth)

33407 (NP-18832) FORMATION OF PARAMAGNETIC DEFECTS BY γ IRRADIATION OF A Y-TYPE ZEOLITE. Abou Kais, Antoine (Lyon Univ. (France). Faculte des Sciences). 1970. 60p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

During zeolite calcination under vacuum, the dehydroxylation of protonated zeolite begins at 450°C. Acceptor centers, capable of ionizing anthracene into its A^+ radical, were observed with the zeolites calcinated at various temperatures. Irradiation induces dehydroxylation in low-temperature calcinated zeolites and structure modifications in dehydroxylated solids; but irradiation modifies only slightly weak acceptor centers. The ESR spectrum of zeolite NH_4Y, irradiated under vacuum at 77°K, consists of a central signal and a doublet. The doublet is due to the presence of atomic hydrogen trapped in the solids. The study of the central signal demonstrates that the release of NH_3 and H_2O from the calcinated solid between 25 and 450°C liberates, after irradiation, V or F centers (E'_1, F_1). Atomic hydrogen was found to be stable at 77°K and its escape by heating at 93°K is due to a second-order reaction. A relation between atomic hydrogen and the Brönsted acidity of the solid was found. (France)

33408 (NP-18836) PHONON SCATTERING IN GALLIUM ANTIMONIDE. THE EFFECT OF ZINC AND TELLURIUM DOPING AND ELECTRON IRRADIATION. Cazal-Poujade, Anne-Marie (Montpellier Univ. (France). Faculte des Sciences). 1970. 200p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The effect on the thermal conductivity at low temperature of doping antimony and gallium with tellurium and zinc and electron irradiation was studied. The effect of progressive compensation by tellurium doping on phonon scattering was established, the material remaining p-type. A systematic study at 300°K was made of n-type materials with apparent carrier concentrations between 1.6×10^{17} and 10.6×10^{18} cm^{-3}. The variation in the additional thermal resistivity with carrier concentration was evaluated. The effect of Zn doping on the electrical properties and the thermal conductivity was examined permitting the effects of impurities on the different types of carrier conduction to be determined (isolated impurities, band impurities, and overlapping bands). The effect of the irradiation at 40°C of n- and p-type GaSb with 4-MeV electrons was studied. The n- to p-type transition caused by the radiation was studied and the importance of the levels introduced and their charge states on phonon scattering was estimated. Irradiated nondoped p-type GaSb was studied in order to establish the effect on K of the levels and defects introduced. (210 references are cited). (France)

33409 ELECTRON RADIATION DAMAGE IN COPPER IN THE HIGH VOLTAGE ELECTRON MICROSCOPE. Fisher, S. B. (Central Electricity Generating Board, Berkeley, Eng.). Radiat. Eff.; 7: 173-7(Feb 1971).

The various factors influencing the nucleation of radiation damage in the HVEM are reviewed. A method for obtaining quantitative information from observations is given. The effect of reirradiation at room temperature on the damage formed at elevated temperatures is shown. This effect may give experimental information concerning the strain fields surrounding large dislocation loops. (auth)

33410 EFFECT OF THE DEFECTIVE STRUCTURE ON X-RAY DIFFUSE SCATTERING. Braude, I. S. (Inst. of Low Temperature Physics and Technology, Kharkov). Ukr. Fiz. Zh. (Russ. Ed.); 16: 464-8(Mar 1971). (In Russian).

Measurements of x-ray diffuse scattering were carried out in the strip of slide and far from it. The dislocations increase scattering intensity in the transverse directions of wave propagation and have little influence on a change in the spectrum of longitudinal vibrations. The role of irradiation of the x-ray diffuse scattering is considered side by side with the dislocation effect. It is shown that the contribution of the dislocations and point defects obtained during neutron irradiation is equal for wave propagation in the longitudinal direction. During the transverse vibration, the dilatation that takes place as a result of introducing the point defects is considerably less than the shift strains that appear during plastic deformation. (auth)

33411 Li^+ ION-IMPLANTED SILICON SOLAR CELL. Koh, Youn Kyu; Lee, Chul Chu; Kim, Do Kyong (Yonsei Univ., Seoul). J. Korean Phys. Soc.; 3: No. 2, 49-53(Sep 1970).

Using a 40-keV accelerator, p-type Si wafers were doped with Li ions to form p–n junctions and the photovoltaic effect studied for various wavelengths. Also for each diode an I–V curve was obtained and its relation to the photovoltaic effect studied. In addition, the optical characteristics of the diodes for solar cell applications are reported. (auth)

33412 EFFECT OF HIGH TEMPERATURE ELECTRON IRRADIATION IN GOLD. Izui, K.; Elston, J.; Koehler, J. S. (Univ. of Illinois, Urbana). Contract AT(11-1)-1198. Radiat. Eff.; 7: 149-51(Feb 1971).

Pure gold is irradiated with 2.8-MeV electrons at 450 ± 50°C. Both electrical resistivity and transmission electron microscopy showed damage which anneals at about 800°C. (auth)

33413 SELECTIVE X-RAY GENERATION BY HEAVY IONS. PART 2. MEASUREMENT OF THE CONCENTRATION DISTRIBUTION OF ION-IMPLANTED ANTIMONY IN SILICON BY THE USE OF SELECTIVE HEAVY ION X-RAY EXCITATION. Cairns, J. A.; Holloway, D. F.; Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 7: 167-72(Feb 1971).

This investigation demonstrates how the total concentration distribution of antimony, previously implanted into silicon at 100 keV, may be elucidated without recourse to the usual radioactive isotope techniques. It uses the fact that 100-keV Kr^+ ions can preferentially excite characteristic x rays from antimony, even in the presence of a huge excess of silicon. The resultant high sensitivity for the detection of antimony in silicon is accompanied by the fact that the x rays arise predominantly from less than 100 Å below the surface of the specimen. Thus, bombardment by 100-keV Kr^+ ions is used in conjunction with an anodic stripping technique (which removes 169 ± 20 Å at a time) to obtain the antimony distribution profile in silicon. Consideration is also given to the possibility of obtaining the implanted-antimony range distribution by using 100-keV Kr^+ ions to detect the antimony and simultaneously remove silicon by sputtering. (auth)

33414 SIMULATION OF HIGH FLUENCE FAST NEUTRON DAMAGE WITH HEAVY ION BOMBARDMENT. Kulcinski, G. L.:

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Laidler, J. J.; Doran, D. G. (Battelle-Northwest, Richland, Wash.). Radiat. Eff.; 7: 195-202(Feb 1971).

316 stainless steel was irradiated with 5-MeV Cu ions to a fluence of 2×10^{16} ions/cm^2 at 500°C. Transmission electron microscopy of this sample reveals that 6×10^{15} voids/cm^3 of average diameter equal to 180 Å were produced. A method for correlating the fluence of ions with equivalent neutron fluences is described. This method predicts that the Cu bombardment in this study should produce a microstructure similar to that found in steel irradiated with $2-5 \times 10^{22}$ neutrons/cm^2. A comparison of the ion-produced voids with those found after previous neutron irradiation experiments confirms this prediction. (auth)

33415 RECOMBINATION OF CLOSE FRENKEL DEFECTS IN GOLD. Schepp, H. E.; Dworschak, F.; Schuster, H.; Wollenberger, H. (Kernforschungsanlage, Juelich, Ger. Technische Hochschule, Aachen). Radiat. Eff.; 7: 219-22(Feb 1971).

The occurrence of close-vacancy–interstitial pairs in electron-irradiated gold and the annealing temperature of this type of defect were investigated by means of "subthreshold" irradiations. Different samples were irradiated with 3-MeV electrons at five different temperatures between 7.5 and 36°K. These samples containing Frenkel defects were then irradiated at 12°K with 1.2-MeV electrons. This energy is less than the threshold for defect production. During the subthreshold irradiation, defect annihilation rates were measured that depend strongly on the temperature at which the defects had been produced. For 7.5 and 12°K, they are of the same order of magnitude as were found in Al, Cu, Pt, and Ta, and were ascribed to recombination of close-vacancy–interstitial pairs. For defects produced at 22°K, the annihilation rate is smaller by one order of magnitude and even smaller for defects produced at still higher temperatures. It is concluded from this that close pairs become thermally unstable in gold between 12 and 22°K. (auth)

33416 PRODUCTION AND MUTUAL ANNIHILATION OF FRENKEL PAIRS IN LOW TEMPERATURE IRRADIATED ZIRCONIUM. Biget, M.; Maury, F.; Vajda, P.; Lucasson, A.; Lucasson, P. (CNRS, Orsay, France). Radiat. Eff.; 7: 223-9(Feb 1971).

12.5-μ thick zirconium foils were irradiated by monoenergetic electrons in the range 0.5 to 1.7 MeV at liquid helium temperature. To the measured defect production rate a theoretical curve was fitted, assuming an atomic displacement probability function $P_d(T)$ and estimating the multiple displacement contribution. The best fit was obtained with: $P_d = 0$ for $T < 21$ eV; $P_d = 0.16$ for $21 \leq T < 30$ eV; $P_d = 0.55$ for $30 \leq T < 50$ eV; $P_d = 0.61$ for $50 \leq T < 110$ eV; and a Frenkel pair resistivity of 4×10^{-3} Ω cm. The implications of such a multiple displacement function are considered. Isochronal and isothermal annealing studies were performed in the recovery stage I (up to 150°K) and compared with results obtained earlier by Neely. An effect of radiation doping on the behavior of the different substages were observed. (auth)

33417 RANDOMISATION OF CRYSTAL STRUCTURE WITHIN ENERGETIC COLLISION CASCADES REVEALED BY THE SPUTTERING OF Au SINGLE CRYSTALS DURING ION BOMBARDMENT. Nelson, R. S. (Atomic Energy Research Establishment, Harwell, Eng.). Radiat. Eff.; 7: 263-7(Feb 1971).

The ratio of random-to-preferential atomic ejection that occurs from the surface of a gold single crystal during ion bombardment was found to be very sensitive to the ion mass. For instance, in the case of 50-keV Ne^+ ion bombardment preferential ejection dominates, whereas in the case of 50-keV Au^+ ion bombardment preferential ejection is only a small fraction of the total. These results are interpreted in terms of a dynamic randomization of the crystal lattice, which occurs during the creation of energetic atomic collision cascades. The disorder occurs so rapidly that a substantial fraction of atoms sputtered from the surface are ejected from an essentially random structure. It is thought that such gross disorder is only a transient phenomenon and leaves no significant permanent effects, except perhaps for a few clustered defects. (auth)

33418 HELIUM MIGRATION IN PALLADIUM. I. CONCENTRATION DEPENDENCE OF HELIUM RELEASE. Holt, J. B. (Univ. of California, Livermore); Bauer, W.; Thomas, G. J. Radiat. Eff.; 7: 269-73(Feb 1971).

High-temperature gas release from helium-implanted palladium was investigated for He/Pd atom fractions from 5×10^{-6} to 5×10^{-2}. The temperature required for 25% He release increases with increasing dose to an atom fraction of 10^{-4}, where a sudden reversal occurs for higher concentrations. The release is associated with dramatic changes in the surface features of the palladium. A qualitative physical model is presented to explain the data. (auth)

33419 TEMPERATURE DEPENDENCE OF THE RADIATION IONIZATION ENERGY IN SEMICONDUCTORS. Antoncik, E. (Univ. of Aarhus, Denmark). Radiat. Eff.; 7: 275-8(Feb 1971).

The radiation ionization energy ϵ and the Fano factor F in semiconductors are discussed with respect to the Shockley model and its generalizations. The problem of the complex band structure is considered. An attempt is made to incorporate temperature dependence into a generalized Shockley model; the temperature dependence of ϵ turns out to be due to that of the energy gap, while F is temperature-independent. Calculations of ϵ for Ge are in good agreement with experiment, as are Klein's calculations. The situation in Si is more complicated due to the complex band structure of the conduction band. (D.L.C.)

33420 IRRADIATION DAMAGE AND STAGE I RECOVERY OF DEFORMED fcc METALS. Swanson, M. L. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Radiat. Eff.; 7: 289-90 (Feb 1971).

It is pointed out that the conclusion of Jackson and Herschbach (Radiat. Eff., 1: 101(1969)) that the enhancement in damage rate by the dislocation resistivity increment can be found from the suppression in stage I recovery is not supported by the evidence. The kinds and mobility of the defects produced by defocusing of collision chains at dislocations are described for electron, deuteron, and neutron irradiations. (D.L.C.)

33421 , XENON DIFFUSION IN SINGLE CRYSTALS OF ALKALI METAL IODIDES. Mears, Luther Daniel. Raleigh, N. C.; North Carolina State Univ. (1970). 154p. University Microfilms Order No. 71-10,258.

Thesis.

The diffusion of Xe in single crystals of CsI, RbI, and KI was studied. In the absence of significant natural defects, radiation damage, and high gas concentration effects, gas release kinetics consistent with the classical solutions of gas diffusion were obtained. These "classical" results were obtained by homogeneously doping the crystals with ^{133}I, the ^{133}Xe precursor, and fission-recoil doping the ^{133}Xe into the surface layers of the crystals at sufficiently low concentrations. The observed diffusion activation energy was approximately one eV for each of the crystals. With the "classical" results serving as a basis for comparison, the effects of natural defects, radiation damage-induced defects, and high gas concentrations were studied independently in the CsI crystals. Natural defects, produced through special crystal growing procedures, acted as effective gas atom traps. These traps were characterized by high binding energies for gas atom retention. The radiation-damage-induced defects were produced by a high-fission-fragment concentration with the fission-recoil doping technique. These defects also acted as gas atom traps, but exhibited significantly lower binding energies for gas atom retention than the natural defects. Radiation-damage trap annealing was observed with increasing annealing temperature which resulted in "classical" gas release results at temperatures higher than 250°C. A high gas concentration was produced through neutron transmutation reactions and dissolving stable Xe into the lattice during crystal growth. The gas-release behavior was consistent with a gas atom clustering process that produced uniformly lower diffusion coefficients at all annealing temperatures. The mechanism of Xe diffusion in the crystals of the present study as well as rare gas diffusion in the alkali halide crystals, in general, was consistent with diffusion in vacancy clusters, possibly divacancies. Consideration of the interstitial diffusion mechanism proposed by Norgett and Lidiard (1968) in explaining the results of the present study and the results reported by Felix (1967) and (1968) indicated serious deficiencies. Gas diffusion in vacancy clusters was qualitatively expressed by simple chemical equilibrium rate equations which accounted for gas atom trapping by the dissociation of a gas atom with the mobile vacancy cluster, association of the mobile gas atom with radiation-damage-induced traps, and gas-atom clustering interactions involving two gas atoms. (Diss. Abstr. Int., B)

33422 NEW OXYGEN CENTERS IN KCl SINGLE CRYSTALS. Andersen, T.; Baptista, J. L. (Univ. of Aarhus, Denmark). Phys. Status Solidi (b); 44: No. 1, 29-38(1 Mar 1971).

Doping of pure KCl with oxygen in a closed system leads to formation of a new oxygen-containing center. Absorption, fluorescence, and ESR spectroscopy have been used together with chemical analysis to characterize the center. It is suggested that the center is an O_2^{2-}–anion vacancy association. The radiolysis of the doped KCl single crystals and the influence of subsequent annealing treatments were investigated. (auth)

33423 VACANCIES AND INTERSTITIALS IN LEAD. Seeger, A. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Phys. Lett.; 35A: No. 2, 135-6(17 May 1971).

It is shown that the experimental data on lead permit an un-

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ambiguous assignment of recovery stage III to the migration of self-interstitials and of recovery stage IV to monovacancy migration. (auth)

33424 MULTIPLE SCATTERING JUSTIFIES DEPTH DEPENDENCE OF CRITICAL ANGLES. Campisano, S. U.; Foti, G.; Grasso, F.; Rimini, E. (Univ., Catania, Italy. Istituto Nazionale di Fisica Nucleare, Catania, Italy). Phys. Lett.; 35A: No. 2, 119-20(17 May 1971).

Measurements on proton angular yields in Ge ⟨111⟩ at different temperatures and depths are compared with calculations including the nonconservation of channeled-ion transverse energy. (auth)

33425 EFFECT OF γ-IRRADIATION ON THE ANGULAR DISTRIBUTION OF ANNIHILATION PHOTONS IN TUNGSTEN SINGLE CRYSTALS. Adamenko, A. A.; Shalaev, A. M. (Inst. of Physics of Metals, Kiev). Phys. Status Solidi (b); 43: No. 2, K147-8(1 Feb 1971).

A tungsten specimen, annealed at 2000°C, was irradiated with 1.6×10^9 R γ rays at 50°C, and the angular distribution of positron annihilation was measured before and after irradiation. The resulting change was similar to that induced by quenching and opposite to that by plastic deformation; an annealing at 1800°C restored the initial form. The change is attributed to a decrease in the probability of positron annihilation with conduction electrons; in irradiated material, a positron annihilates in compressed material. (D.L.C.)

33426 LOW TEMPERATURE α-IRRADIATION OF WHITE TIN AND SUBSEQUENT RECOVERY. von Heyden, G.; Stals, L.; Nihoul, J. (SCK-CEN, Mol, Belgium). Phys. Status Solidi (b); 43: No. 2, K149-51(1 Feb 1971).

A high-purity tetragonal tin foil were irradiated at 2.5 to 6°K with alpha particles from ^{242}Cm sources, and the defect production and annealing were studied by means of electric-resistivity measurements. From the isochronal recovery curve and spectrum below 12°K, it is seen that substantial recovery (18%) occurs below 4.2°K. Prominent peaks occur at 7.5, 8.9, and 10.2°K, with two small peaks at 5.5 and 6.5°K. Rough recovery experiments above 12°K show complete recovery at 300°K. (D.L.C.)

33427 PRODUCTION OF COLOUR CENTRES IN SOME ALKALI HALIDES BY LOW ENERGY ELECTRON IRRADIATION. Lord, D. G. (Univ. of York, Heslington, Eng.). Phys. Status Solidi (b); 43: No. 2, K115-18(1 Feb 1971).

Surfaces of KCl, NaCl, LiF, and NaF were bombarded with electrons of energy 200 eV to 2 keV, and the optical absorption was measured. The growth of F and M centers was followed. The F-center production efficiency decreases with beam energy for LiF. The uv absorption spectrum of KCl after irradiation with 200-eV electrons shows three previously unobserved bands; the centers responsible for these bands must be produced near the crystal surface. (D.L.C.)

33428 ACTION OF X RAYS ON ALKALI-METAL ION-DOPED STRONTIUM CHLORIDE. Baltog, Ioan; Lefrant, Serge; Houlier, Bernard; (and others) (Paris Univ., Orsay, France). Compt. Rend., Ser. B; 272: No. 12, 767-9(22 Mar 1971). (In French).

Numerous color centers are produced when strontium chloride, doped with alkali metal ions, is irradiated with x rays. The existence of V_k centers was established. It is most likely that perturbed F centers appear which, when heated, give rise to perturbed M centers and then nonperturbed F centers. (France)

33429 PRODUCTION OF F-CENTRES BY UV AND ELECTRON IRRADIATION OF KI SINGLE CRYSTALS. Bailey, I.; Tubbs, M. R. (Univ. of Warwick, Coventry, Eng.). Phys. Status Solidi (b); 43: No. 2, K173-6(1 Feb 1971).

The relative efficiencies of uv and electron irradiation for producing F centers in KI at room temperature were studied in order to elucidate the mechanism of F-center formation. For uv, the F-center concentration saturates at $\sim 3 \times 10^{17}/cm^3$ after a dose of $\sim 4 \times 10^{19}$ keV/cm³. For 100- and 50-keV electrons, the F-center concentration saturates at $2 \times 10^{18}/cm^3$ after a dose of 4×10^{19} keV/cm³. The results show an electron efficiency ten times larger than the uv efficiency, indicating that fast electrons produce F centers by an intrinsic process and that nonradiative recombination does not take part. The dependence of the coloration on the radiation quality is discussed. (D.L.C.)

33430 ELECTRON PARAMAGNETIC RESONANCE STUDIES OF THE V_K CENTER IN SINGLE-CRYSTAL POTASSIUM, RUBIDIUM, AND SODIUM IODIDE. Repka, Ronald John. Clemson, S. C.; Clemson Univ. (1970). 98p. University Microfilms Order No. 71-9519.

Thesis.

Electron paramagnetic resonance (EPR) studies of the V_K center in x-irradiated samples of single-crystal $KI(NO_3)$, KI(Tl), RbI(Tl), and NaI(Ag) were carried out at low temperature. V_K centers were generated in $KI(NO_3)$, KI(Tl), and RbI(Tl) by irradiating samples with 100-keV x rays at 77°K, while centers in NaI(Ag) were generated with 100-keV x rays at 40°K. Some of the experimental data was analyzed with computer programs. Output from these programs consisted of values for the spin Hamiltonian parameters $g_{\|}$, $g_{\perp}$, $A_{\|}$, and $A_{\perp}$. Optimized values for these parameters were obtained by varying their initial, estimated values until a best fit was obtained between experimental data and theoretically predicted values for certain spectral line positions using a least-squares fitting method. The method for obtaining values for the spin Hamiltonian parameter P is outlined. Values for the parameters $g_{\|}$, $g_{\perp}$, $A_{\|}$, $A_{\perp}$, and P are presented in tabular form. Experimental values for the spectral line widths are listed, as well as calculated values for the quantities α^2 and β^2, which indicate, respectively, the amount of s and p character in the wave function for the paramagnetic electron of the V_K center. A general development of the spin Hamiltonian used in EPR work is presented. The specific spin Hamiltonian and perturbation treatment used in this work to analyze the EPR spectra of the I_2^- center in the materials used in the study is given. Experimental and theoretical values for certain spectral line positions are tabulated. Representative spectra for all materials are presented. (Diss. Abstr. Int., B)

33431 EFFECT OF ELECTRON IRRADIATION DAMAGE ON THE RESISTIVITY AND PIEZORESISTIVITY OF N-TYPE SILICON. Loggins, Chester DeWitt Jr. Raleigh, N. C.; North Carolina State Univ. (1970). 174p. University Microfilms Order No. 71-10,311.

Thesis.

The resistivity and Hall coefficient of several n-type, electron-irradiated silicon samples were measured at 250 to 360°K. The samples studied were of three different crystallographic orientations, ⟨100⟩, ⟨110⟩, and ⟨111⟩, and were stressed uniaxially with compressive stresses as large as 2.5×10^9 dynes/cm² in order to determine the effect of 7-MeV electron irradiation damage on the piezoresistivity of n-type silicon. The experimental resistivity results indicate that two defect levels are important in determining the resistivity of the irradiated samples. A model is presented that quantitatively accounts for the observed zero-stress resistivities and is consistent with the experimental Hall coefficient data. Models are developed for the piezoresistivities of the variously oriented samples, and curve-fitted to the piezoresistivity data obtained on some of the samples. To obtain a good fit to the experimental data with these models, it was found necessary to include the effect of stress on the relaxation times of conduction electrons as well as considering the detailed splitting of the Si-A center acceptor level with stress. In the irradiated samples, the Si-A center defect essentially controls the conduction band electron concentration over the experimental temperature range. The splitting of this level with stress is important in determining the effect of stress on the total conduction band electron concentration for the irradiated samples. (Diss. Abstr. Int., B)

33432 DEFECT STRUCTURES IN SINGLE-CRYSTAL THORIUM OXIDE. Tint, G. Stephen. Philadelphia; Temple Univ. (1970). 178p. University Microfilms Order No. 71-10,588.

Thesis.

An ESR study was performed in order to describe and find models for charge-trapping point defects in ThO_2. The initial ESR experiments were designed to initiate and correlate the observed ESR lines with the thermoluminescence (TL) glow peaks. They consisted, first of all, of annealing measurements on the same ThO_2 single crystals used in the TL investigation, in which the samples were irradiated with ultraviolet light at liquid nitrogen temperature and then heated at a constant rate. However, instead of observing the luminescent emission as in the TL studies, these experiments consisted of measuring the growth or reduction of the intensity of the ESR lines and the temperatures at which these occur. The ESR studies revealed the presence of four sets of absorption lines, all with negative g shifts, which had the same annealing temperatures as the −158, −103, +149, and +174°C glow peak temperatures, and two sets of lines, with positive g shifts, which annealed at −127 and +151°C, respectively. In order to gain information on the structure of these defects, the angular variation of the ESR spectra were measured. The signs of the g shifts, the symmetry of the spectra, and the annealing temperatures were used to suggest models for each of them. Values for the g shifts parallel and perpendicular to the symmetry axes were then calculated from these models and compared with the measured ones. The qualitative agreement was excellent while the quantitative agreement was quite reasonable. (TSS) (Diss. Abstr. Int., B)

Physical Properties

Refer also to abstracts 32678, 32679, 32700, 32710, 32711, 32717, 32746, 32786, 33072, 33180, 33181, and 33391.

33433 ELECTRONIC STRUCTURE OF CERIUM IN BINARY INTERMETALLIC COMPOUNDS. Olcese, G. L. (Univ., Genoa). pp 143-9 of Les Elements des Terres Rares. Vol. 1. Paris; Centre National de la Recherche Scientifique (1970). (In French).

From international symposium on rare earths; Paris and Grenoble, France (5 May 1969). See CONF-690517-(Vol.1).

From the structural data and from the results of magnetic susceptibility measurements in the temperature range 4.2 to 500°K, the electronic configuration of cerium in its binary phases, with the metals of the I, II, III, IV, V and VIII Groups, are discussed. In particular, the compounds in which the cerium shows anomalous valency behavior are studied and the transitions to the valency band of the 4f electrons are discussed. (auth) (France)

33434 LOCAL COUPLING IN THE ALLOY Nb_3Sn. Korsunskii, M. I.; Genkin, Ya. E.; Morkovnin, V. I. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 23-8(Mar-Apr 1970). (In Russian).

A local coupling scheme for the alloy Nb_3Sn was examined on the basis of a model in which the separation of valence electrons into two groups is assumed. Estimation limiting calculations for the Debye temperature for Nb, Zr, Mo, and the alloy Nb_3Sn were carried out. (tr-auth)

33435 EFFECTS OF PULSED FIELD MAGNETIZATION ON THE MAGNETIC BEHAVIOUR OF R_3Co COMPOUNDS. Taylor, K. N. R.; Primavesi, G. J. J. Phys., F (London); 1: L7-9(Mar 1971).

Results are presented which indicate that the metamagnetic behaviour of the R_3Co compounds (where R is a rare earth element) is probably the consequence of a time-dependent behaviour of the magnetization at low temperatures. Magnetization curves obtained in pulsed fields are appreciably different from those obtained in static fields and, in general, open hysteresis loops are observed, along with much higher values of the critical fields. It appears that the critical field values may depend upon the rate of field increase. (auth) (UK)

33436 LUMINESCENCE AND F' FORMATION INVOLVING SPIN-POLARIZED F CENTERS IN KCl. Porret, Francis; Luety, Fritz (Univ. of Utah, Salt Lake City). Phys. Rev. Lett.; 26: 843-6(5 Apr 1971).

The electronic processes following optical excitation of F centers in KCl are drastically changed if the F electrons are spin-polarized by magnetic fields at low temperatures (1.7°K). As the spin-aligned configuration of the F' center is forbidden, two effects appear: (1) The $F \rightarrow F'$ conversion by conduction electrons becomes suppressed, and (2) the radiationless de-excitation of excited F centers (caused by electron tunneling into neighboring F' center states) becomes suppressed, producing increases of the F luminescence up to a factor 4. (auth)

33437 ENERGY-DEPENDENT PHOTOEMISSION INTENSITIES OF f STATES IN EuS, GdS, AND US. Eastman, D. E. (IBM Thomas J. Watson Research Center, Yorktown Heights, N. Y.); Kuznietz, Moshe. Phys. Rev. Lett.; 26: 846-50(5 Apr 1971).

Photoemission measurements of *f* states and valence-band energies of EuS, GdS, and US for photon energies from 5 to 41 eV show characteristic energy-dependent emission strengths of p, d, and *f* states. These energy dependences permit the l character of various levels to be identified in many cases. For example, the emission strength of the $4f^7$ level in EuS increases about 100-fold relative to the 3-eV wide valence p band which lies just below the $4f^7$ level. GdS shows a deep $4f^7$ level at about 9 eV below the Fermi level E_F, and US shows an *f*–d band at E_F. (auth)

33438 METAL–INSULATOR TRANSITIONS OF V_2O_3: MAGNETIC SUSCEPTIBILITY AND NUCLEAR-MAGNETIC-RESONANCE STUDIES. Gossard, A. C.; Menth, A.; Warren, W. W. Jr.; Remeika, J. P. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., B; 3: 3993-4002(15 Jun 1971).

Magnetic susceptibilities were measured and ^{51}V nuclear magnetic resonances were observed in a series of compounds $(V_{1-x}Cr_x)_2O_3$ and $(V_{1-x}Al_x)_2O_3$ $(0 \leq x \leq 0.04)$. The compounds are of interest because of their metal–insulator transition in the composition and temperature (4.2 to 900°K) range studied. The paramagnetic insulating phase is found to possess a higher susceptibility than the metallic phase, a more positive ^{51}V nuclear-resonance frequency shift, and a reduced d-spin hyperfine coupling constant. The nuclear-resonance relaxation and linewidth are understood in terms of a metallic state with a high-band susceptibility and an insulating state with local paramagnetic moments. Anomalies observed previously in ^{51}V frequency-shift-susceptibility relationships for pure V_2O_3 are shown to result from the gradual supercritical change from metallic-like to insulating-like behavior of pure V_2O_3. A high degree of covalency in the insulating phase is implied by the frequency shifts of ^{27}Al nuclear resonances also observed in the samples containing Al. (auth)

33439 OPTICAL PROPERTIES OF SINGLE-CRYSTAL CADMIUM. Bartlett, R. J.; Lynch, D. W.; Rosei, R. (Iowa State Univ., Ames). Phys. Rev., B; 3: 4074-83(15 Jun 1971).

Measurements were made of the reflectivity and/or absorptivity of cadmium from 0.15 to 20 eV, using polarized light with the electric vector both perpendicular and parallel to the c axis of the crystal. In the visible and infrared spectra, both polarizations yielded strong absorption peaks. For perpendicular polarization, the main peak was at 0.98 eV and was attributed mainly to transitions between bands along the L–H symmetry line. Also in this polarization, there was an absorption edge at 0.29 eV. This may be due to transitions near the point K in the Brillouin zone. For parallel polarization, the main absorption peak was at 1.10 eV and was attributed to transitions between bands along Γ–K, Γ–M, and L–H. No low-energy absorption edge was found for parallel polarization. Agreement between the experimental data and the calculations of Kasowski based on a nonlocal–pseudopotential model was fairly good. There was no agreement between the data and calculations based on a local–pseudopotential model. At low temperatures, the long-wavelength absorptivities were approximately constant, in agreement with theory for the anomalous-skin-effect region. Using the theory of Kliewer and Fuchs and the experimental data, parallel and perpendicular effective masses were calculated to be 1.09 m_0 and 1.61 m_0, respectively. The weighted average of these is in good agreement with the thermal effective mass for cadmium. The low-energy data support the theory of Kliewer and Fuchs and tend to confirm the volume absorption process suggested by Holstein. (auth)

33440 ROLE OF EFFECTIVE MASS IN INTERPRETING THE KNIGHT SHIFT IN CADMIUM UPON MELTING. Jena, P.; Halder, N. C. (State Univ. of New York, Albany). Phys. Rev. Lett.; 26: 1024-7(26 Apr 1971).

The abrupt changes of Knight shift K_s and nuclear spin relaxation time T_1 in Cd upon melting were examined by studying the spin susceptibility χ_s and spin density S at the melting point. It is found that the density-of-states effective mass m^*/m in Cd changes by 27% upon melting, while the spin density changes by only 8%. Both of these changes combined satisfactorily explain the abrupt changes of K_s and T_1 upon melting. (auth)

33441 MAGNETOSTRICTION AND MAGNETIC BREAKDOWN IN CADMIUM. Carter, J. M.; Sparlin, D. M. (Univ. of Missouri, Rolla). Phys. Rev. Lett.; 26: 700-3(22 Mar 1971).

Studies of the monotonic magnetostriction of cadmium at 4.2°K in applied magnetic fields to 70 kG show that the angular variation of an extremal point H_m is proportional to sec θ. The magnitude of H_m is in close agreement with the onset of a breakdown orbit γ_8 observed for the applied field within 35° of the c axis. The range of observation of H_m coincides with the range of the orbit γ. (auth)

33442 SIMPLE THEORY OF THE MAGNETIC PROPERTIES OF RARE-EARTH METALS. Falicov, L. M.; Goncalves da Silva, C. E. T. (Univ. of California, Berkeley). Phys. Rev. Lett.; 26: 715-17(22 Mar 1971).

A simple theory for the magnetism of the rare-earth metals is presented, based on assuming strongly correlated, well-defined f-electron states of an atomiclike character that are weakly hybridized with conduction-band states. This hybridization plays the role of an indirect exchange interaction. A model calculation is presented: It yields for various values of the two relevant parameters ferromagnetic, antiferromagnetic, and helical arrangements. These arrangements are strongly dependent on the features of the conduction-electron band structure (Fermi surface). Order-of-magnitude estimates give reasonable agreement for physical parameters as determined from unrelated experiments. (auth)

33443 MAGNETIC PROPERTIES OF THE VARIOUS PHASES IN THE DIAGRAMS VANADIUM–TIN, NIOBIUM–TIN, AND TANTALUM–TIN. Basile, Francoise (Paris Univ., Orsay, France). Ann. Chim. (Paris); 5: 367-72(Sep-Oct 1970). (In French).

The temperature dependence of the susceptibility exhibited by group Va transition metals, and the V_3Sn, Nb_3Sn, and Ta_3Sn alloys which have A_{15} structures is small and $(d\chi/dT)$ negative; the susceptibility at room temperature of A_{15} alloys is similar to that of

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the uncombined metal. The susceptibility of the V atom in V–Sn solid solutions decreases with increasing Sn content. V_3SnDo_{19}, V_2Sn_3, Nb_6Sn_5, and Nb_2Sn_3 present a Pauli paramagnetism, independent of temperature; in each diagram, the susceptibility of the metal decreases with increasing Sn content. In the three diagrams, the transition atomic susceptibility of isostructural compounds decreases from V to Ta. (France)

33444 SPLITTING OF THE π BANDS IN GRAPHITE. Feuerbacher, B.; Fitton, B. (European Space Research Organization, Noordwijk, Netherlands). Phys. Rev. Lett.; 26: 840-2(5 Apr 1971).

The splitting of the π bands in graphite due to multilayer interaction was observed directly for the first time for the valence-band states at P and Q on the vertical face of the Brillouin zone, using photoemission techniques. The splitting is found to be 0.8 ± 0.1 eV for both P and Q, giving a value of 0.42 eV for the parameter γ_1, in agreement with other experiments. (auth)

33445 MAGNETICALLY INDUCED SIGN CHANGE IN THE THERMOPOWERS OF ALUMINUM AND INDIUM. Averback, R. S.; Bass, J. (Michigan State Univ., East Lansing). Phys. Rev. Lett.; 26: 882-4(12 Apr 1971).

Upon application of a sufficiently strong transverse magnetic field, the low-temperature thermopowers of both aluminum and indium change sign from negative to positive. In aluminum the change in sign is produced by a change in sign of the "electron-diffusion" component. In both metals, the magnitude of the "phonon-drag" component is increased. (auth)

33446 MAGNETIC AND OTHER PROPERTIES OF OXIDES AND RELATED COMPOUNDS. PART A. Hellwege, K.-H.; Hellwege, A. M. (eds.). Landolt-Boernstein. Numerical Data and Functional Relationships in Science and Technology. New Series. Group III. Crystal and Solid-State Physics. Volume 4. Berlin; Springer-Verlag (1970). 382p. $60.00. (In English and German).

This part covers Fe oxides and Fe–Me–O systems, compounds with lanthanide and actinide elements of special structure types, perovskites, and Y and rare-earth Fe garnets. Crystallographic and magnetic properties are presented, including optical, electrical, and technological data. For an index of the substances, see Part B. (D.L.C.)

33447 MAGNETIC AND OTHER PROPERTIES OF OXIDES AND RELATED COMPOUNDS. PART B. Hellwege, K.-H.; Hellwege, A. M. (eds.). Landolt-Boernstein. Numerical Data and Functional Relationships in Science and Technology. New Series. Group III. Crystal and Solid-State Physics. Volume 4. Berlin; Springer-Verlag (1970). 682p. $117.70. (In English and German).

This part covers non-iron garnets, spinels, and hexagonal ferrites. Graphs and tables are presented of the magnetic and crystallographic data. An index of the substances in both Parts A and B is included. (D.L.C.)

33448 EMISSIVITY OF METALS OF THE IVb SUBGROUP AT HIGH TEMPERATURES. Zhorov, G. A. High Temp. (USSR) (Engl. Transl.) 8: 501-4(May-Jun 1970).

Translated from Teplofiz. Vys. Temp.; 8: 532-6(May-Jun 1970).

The integral hemispherical emissivity and the electrical resistivity of zirconium and hafnium were determined in the temperature range above 1000°K. Formulas are obtained that establish the connection between the integral emissivity and the electrical resistivity for titanium, zirconium, and hafnium. The dependence of these properties on the electronic structure is considered. (auth)

33449 EFFECT OF MAGNETIC FIELD ON THE CRYSTAL STRUCTURE OF DYSPROSIUM. II. Finkel, V. A.; Belovol, V. S. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 60: No. 3, 1046-56(Mar 1971). (In Russian).

The effect of a magnetic field of strength up to 16 kOe on the crystal structure of polycrystalline dysprosium is studied at temperatures between 77 and 300°K. Special attention is directed to an investigation of anisotropic effects due to different orientation of the crystallites (and domains) in the polycrystalline aggregate with respect to the magnetic-field vector. It is shown that a magnetoheterogeneous state, i.e., the coexistence of ferromagnetic and antiferromagnetic phases, occurs in a certain range of temperatures and magnetic field strength. Reorganization of the crystal lattice of dysprosium in the magnetic field is responsible for the giant magnetostriction effects in the magnetic-ordered state. It is found that discontinuities of the crystal-lattice parameters in antiferromagnetism–ferro magnetism phase transitions of the first kind increase with decreasing temperature. The true magnetostriction of dysprosium is characterized by strong anisotropy. (auth)

33450 ROLE OF INTERELECTRON COLLISIONS IN THE ELECTRIC RESISTANCE OF TRANSITION METALS. Volkenshtein, N. V.; Novoselov, V. A.; Startsev, V. E. (Inst. of the Physics of Metals, Sverdlovsk, USSR). Zh. Eksp. Teor. Fiz.; 60: No. 3, 1078-85(Mar 1971). (In Russian).

The temperature dependences of the electric resistance of yttrium, zirconium, niobium, molybdenum, lanthanum, lutetium, hafnium, tantalum, tungsten, rhenium, and iridium are measured at temperatures between 0.38 and 70°K (in superconductors the lower limit of the measurement temperature was T_c). The contribution to the electric resistance of the metals due to interelectron collisions is determined. The magnitude of the contribution qualitatively correlates with magnitude of the electron specific heat. (auth)

33451 THERMOREFLECTANCE OF GRAPHITE. Anderegg, M.; Feuerbacher, B.; Fitton, B. (European Space Research Organization, Noordwijk, Netherlands). Phys. Rev. Lett.; 26: 760-2(29 Mar 1971).

The thermoreflectance of graphite was measured in the energy range 4.4 to 5.5 eV at 80°K. Three peaks at 4.52, 4.76, and 4.82 eV were identified as M_1-type singularities and assigned to transitions taking place at the points Q and L in the Brillouin zone. (auth)

33452 CRYSTAL FIELD AND MAGNETIC PROPERTIES OF CeBi. Tsuchida, T.; Suzawa, T.; Nakamura, Y. (Kyoto Univ.). Phys. Status Solidi (b); 44: No. 1, K25-8(1 Mar 1971).

The magnetic structure of CeBi was studied by neutron diffraction; peaks were observed on (110), (201), (112), and (221) reflections but not on (001). The sublattice magnetization was calculated for various molecular-field constants, and its temperature dependence was found to be complicated. The electronic entropy of the Ce^{3+} ion in the crystal field also has an anomalous temperature dependence. (D.L.C.)

33453 MAGNETIC SUSCEPTIBILITY OF COMPOUNDS IN THE Sm–Te SYSTEM. Lashkarev, G. V.; Yarembash, E. I.; Karabekov, A.; Giletskii, N. P. (Inst. of Semiconductors, Kiev. Inst. of Common and Inorganic Chemistry, Moscow). Phys. Status Solidi (b); 44: No. 1, K41-4(1 Mar 1971).

The magnetic susceptibilities of the following samarium tellurides were measured at 80 to 300°K: SmTe, Sm_3Te_4, $SmTe_2$, Sm_2Te_3, Sm_2Te_5, Sm_3Te_7, and $SmTe_3$. The effective magnetic moments of the Sm ions were calculated, and the variation of the valence of the ions is discussed. (D.L.C.)

33454 MONTE CARLO CALCULATION OF IMPACT IONIZATION GENERATION RATE. Curby, R. C.; Ferry, D. K. (Texas Tech. Univ., Lubbock). Phys. Lett.; 35A: No. 2, 64-5(17 May 1971).

Results of calculation of impact ionization generation rate are presented for electrons in n-type InSb with a strong electric field. These results were obtained by the Monte Carlo calculations and are compared with experiment. (auth)

33455 ELECTRICAL RESISTIVITIES OF THE INTERMETALLIC COMPOUNDS ThPt, UPt, NpPt, AND PuPt. Hill, H. H.; Elliott, R. O. (Los Alamos Scientific Lab., N. Mex.). Phys. Lett.; 35A: No. 2, 75-6(17 May 1971).

Resistivity measurements on four actinide–platinum compounds were carried out in the range 1.5 to 300°K. ThPt exhibits normal metallic behavior; UPt shows evidence for a magnetic transition, as has been reported previously; and NpPt and PuPt exhibit resistivity anomalies at low temperatures, which may also be indicative of magnetic ordering. (auth)

33456 EFFECTS OF EXCHANGE ON THE BAND STRUCTURE OF ZINC AND CADMIUM. Borghese, F.; Denti, P. (Univ., Messina, Italy). Nuovo Cim.; 3B: No. 1, 34-44(11 May 1971).

The applicability to crystals of the Slater and of the Kohn and Sham approximations to the exchange was investigated through the behavior of the d-bands of zinc and cadmium within the framework of the APW method. Both approximations were found to give correctly the features of the Fermi surface in both metals. However, the Slater approximation locates the d-bands very deeply. On the contrary, in the Kohn and Sham approximation, the d-bands appear as resonances of the muffin-tin potential, within the width of the s-like conduction band. Such a strong rising could possibly not be entirely attributed to inadequacy of the exchange approximations but, more probably, to the lack of dynamical correlation in the crystal potential. (auth)

33457 DIFFUSION DES RAYONS X AUX PETITS ANGLES. (Scattering of X Rays at Small Angles). Renouprez, A. J. Bibliography 4. Utrecht; International Union of Crystallography (1970). 72p. $3.00. Polycrystal Book Service, Pittsburgh.

A total of 584 references, with brief summaries, are divided into sections dealing with theory, experimental apparatus, application to solids, application to biological macromolecules and solutions, and small-angle scattering of neutrons and electrons. The years 1954 to 1969 are covered. An author index is included. (D.L.C.)

33458 WORK FUNCTION OF TITANIUM AND NIOBIUM CARBIDES IN THE HOMOGENEITY REGION. Samsonov, G. V.; Okhremchuk, L. N.; Upadkhaya, G. Sh.; Naumenko, V. Ya. (Inst. of Materials Science, Kiev). High Temp. (USSR) (Engl. Transl.); 8: No. 4, 870-2(Jul-Aug 1970).

Translated from Teplofiz. Vys. Temp.; 8: No. 4, 921-2(Jul-Aug 1970).

An experimental investigation was made of the work functions of Ti and Nb monocarbides in their homogeneity regions, and the main regularities were determined of its change for different compositions, with consideration of the characteristics of the electronic structure of carbide phases. The initial specimens were cylindrical 8 mm in diameter and 10 mm high, made of the investigated carbide, and cut out in tablet form by the electrospark method for the measurements. The work function was determined by the total-current method in the 1400 to 2100°K range. The thermionic emission properties of titantium and niobium monocarbides in their homogeneity regions showed a substantial change of the work function with a change of their composition. (J.C.W.)

33459 THEORY OF ELASTIC STIFFNESS c_{33} OF GADOLINIUM IN THE SPIN-ROTATION REGION. Levinson, L. M. (Weizmann Inst. of Science, Rehovot, Israel. General Electric Research and Development Center, Schenectady, N. Y.). J. Phys. Chem. Solids; 32: No. 5, 981-92(May 1971).

A simple, model free-energy function was constructed to interpret the anomalous decrease in the elastic stiffness c_{33} of Gd in the spin-rotation region. The model qualitatively exhibits the observed drop in c_{33}, and an order of magnitude estimate of the decrease is in agreement with measured values. In the presence of sufficiently large magnetic fields, spin rotation causes large changes in the shape-dependent magnetostatic self-energy, which "freezes out" strain-induced spin rotation, thereby eliminating the drop in c_{33}. As is borne out experimentally, it is predicted that the anomalous decrease in c_{33} should disappear for fields of the order of 5 kG. The magnetic field dependence of c_{33} is evaluated and fair qualitative agreement with the measurements is obtained. (auth) (UK)

33460 RADIATION EFFECTS ON ELECTRICAL PROPERTIES OF THE UO_2–SiO_2 SYSTEM. Cojocaru, L. N. (Inst. of Nuclear Physics, Bucharest). Stud. Cercet. Fiz.; 23: No. 1, 27-59(1971). (In Rumanian).

The electric conductivity and thermoelectric power of UO_2, SiO_2, and UO_2-SiO_2 over the entire composition range were measured at 400 to 1000°K. The production of defects by neutrons and fission fragments is discussed, and the radiation effects on the physical properties of UO_2-SiO_2 are considered. Effects of neutron doses on the conductivity and thermoelectric power of UO_2-SiO_2 were studied in detail. (D.L.C.)

33461 OPTICAL REFLECTION OF V_2O_5 SINGLE CRYSTALS. Hevesi, I.; Karvaly, B. (Jozsef Attila Univ., Szeged). Acta Phys. Acad. Sci. Hung.; 29: No. 2-3, 182-92(1970).

Reflection measurements were made on vanadium pentoxide single crystals of (010) orientation in the wavelength region 380 to 800 nm. Optical constants were calculated on the basis of reflection spectra obtained with linearly polarized light in $\parallel$ and $\perp$ positions of polarization (the electric vector E being parallel to the crystallographic axes a and c). The results confirmed the values of the refractive index obtained from our transmission measurements in the region of weak absorption (550 to 800 nm), as well as the conclusions concerning the shape of the absorption edge. On the other hand, the measurements gave numerical values of the refractive index at shorter wavelengths and allowed some conclusions to be drawn for regions of anomalous dispersion. (auth)

33462 PRESSURE DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY OF CERIUM. MacPherson, Malcolm Reid. Riverside, Calif.; Univ. of California (1970). 136p. University Microfilms Order No. 71-8800.

Thesis.

The magnetic susceptibility of cerium metal was measured as a function of pressure (0 to 10 kbars) and temperature (0.38 to 300°K). The measurements were made by suspending a small pressurized beryllium copper clamp from a microbalance in an inhomogeneous magnetic field (Faraday method). The atmospheric-pressure, room-temperature susceptibility of γ-phase cerium was found to be 15.8 ± 0.1 emu/gm. At 10 kbars and room temperature, the susceptibility of the α phase (collapsed fcc) was $3.81 \pm 0.15 \times 10^{-6}$ emu/gm. It was suggested on the basis of x-ray diffraction and other experiments that the valence of α cerium is 3.7 rather than 4. The high room-temperature susceptibility might be attributed to 0.3 localized 4f electrons per cerium ion. However, the measured temperature dependence of the susceptibility of α cerium only doubles between 300 and 3°K (far less than expected on the basis of localized electrons). In fact, the susceptibility rises to a peak at 3°K, then falls, indicative of saturation of ferromagnetic rare-earth impurities. It was found that the susceptibility due to 0.036% gadolinium added to a constant susceptibility assumed for α cerium yielded a good fit to the measurements between 1 and 10°K. It is believed that the magnetic susceptibility of α cerium is essentially temperature-independent, which is characteristic of a normal metal. The results, interpreted on a band picture, show a large exchange enhancement. (Diss. Abstr. Int., B)

33463 ELECTRICAL PROPERTIES OF AN ANODIC TANTALUM–ALUMINUM OXIDE DIELECTRIC. Sitarik, Joseph Paul. Bethelhem, Pa.; Lehigh Univ. (1970). 87p. University Microfilms Order No. 71-10,537.

Thesis.

Thin tantalum −45 at. % aluminum alloy films were made by simultaneously sputtering tantalum and aluminum in a glow discharge. The formation and composition of the alloy oxide was studied, and results showed that the oxide was homogeneous and maintained the stoichiometry of the metal. The anodization was nearly 100% efficient and followed Faraday's law. The relative dielectric constant of the alloy oxide at 1 kHz was found to be 17.7. The index of refraction of the oxide and the growth constant of the oxide were determined by ellipsometry to be 2.01 and 15.2 Å/V, respectively. At very high anodization voltages (>400 V), the oxide catastrophically breaks down. In preparation for the ac and dc measurements, a ramp voltage was used to break down capacitors of various areas anodized to 225 volts. From these data the density of flaws was found to be ≈4 per cm^2. The dc current was measured as a function of voltage and temperature. Regions of voltage and temperature where permanent changes in the conduction mechanism were observed were avoided in subsequent measurements. Analysis of the results show that the conduction mechanisms are bulk electronic phenomena. A low-frequency measuring system was developed for this work to cover the range 10 Hz to less than 10^{-3} Hz. The step-response method for measuring loss was investigated, and the validity of the assumption of superposition of current decay with applied voltage was examined. This method was used as an independent measurement of loss in the 10^{-3} to 10^{-2} Hz range. The relative permittivity and loss were measured from 10^{-3} to 10^{5} Hz as a function of temperature. The results indicate bulk phenomena because of the insensitivity to applied voltage. At high temperatures and low frequencies, the loss increases are consistent with the dc ohmic conduction mechanism. At high temperatures (100 to 202°C), and intermediate frequencies (10^{-1} to 10^{3} Hz) the loss rises somewhat. However, this rise does not reflect a single loss mechanism. At intermediate temperatures (−51 to 3°C), the loss is nearly independent of frequency but does not uniquely define a distribution of relaxation times. At low temperatures (−101 to −168°C), the loss increases slightly with frequency and may be represented empirically by $\epsilon'' = A\, e^{BT}$. At present no good physical model exists for this behavior. (TSS) (Diss. Abstr. Int., B)

33464 CRITICAL MAGNETIZATION FLUCTUATIONS IN EuO. Collins, Donald Fairley. Pittsburgh; Carnegie-Mellon Univ. (1971). 147p. University Microfilms Order No. 71-9677.

Thesis.

Bulk critical magnetization fluctuations were detected near the Curie temperature in europium oxide (EuO). The critical fluctuations were detected by measuring the inductance and the equivalent Nyquist resistance of a coil containing the sample. This complex coil impedance was measured both by passive-noise-detection techniques and by driving the coil with an impedance meter. The two methods produced identical results for the coil inductance. A method was developed to calculate the complex susceptibility $\chi'(\omega,T) - i\chi''(\omega,T)$ from the complex coil impedance accounting for shape-dependent demagnetization effects. The dc susceptibility $\chi_0(T)$ and the fluctuation lifetime or magnetization relaxation time $\tau(T)$ were calculated from the complex susceptibility using the relations: $\chi'(\omega,T) = \chi_0/(1 + \omega^2\tau^2)$, and $\chi''(\omega,T) = \chi_0\omega\tau/(1 + \omega^2\tau^2)$. The dc susceptibility was fitted to a power law divergence as $\chi_0(T) \propto (T - T_C)^{-\gamma}$ using γ and T_C as parameters. For the sample with which the largest quantity of data was taken, it was found that $T_C = 69.25 \pm 0.05$°K and that $\gamma = 1.35 \pm 0.01$ in the temperature range $0.001 < |(T - T_C)/T_C| < 0.1$ and for frequencies 500 to 1,000 kHz. This value for γ agrees with the predictions for

XUM

a Heisenberg ferromagnet. The critical magnetization fluctuations were observed to slow down as the Curie temperature was approached from above. This is equivalent to a singularity or divergence in the fluctuation lifetime $\tau(T)$, which was found to diverge in the form $\tau(T) = \tau_0[T - T_C)/T_C]^{-\Delta}$ where $\Delta = 1.4 \pm 0.1$ and $\tau_0 \approx 6 \times 10^{-11}$ sec. (Diss. Abstr. Int., B)

33465 DIOCHROISM OF β-RHOMBOHEDRAL BORON IN THE ABSORPTION EDGE REGION. Juryska, R. (Inst. of Physics, Warsaw). Phys. Status Solidi (b); 44: No. 1, K33-5(1 Mar 1971).

Measurements were made on polished monocrystals 70- to 290-μm thick, with polarized light below 1.7 eV. The c axis was the rod axis, the samples were cut parallel and perpendicular to the rod axis, and the angle between the electric vector and the rod axis was varied. Absorption in the parallel samples changed with this angle, the maximum value occurring at 90°. The absorption coefficient vs photon energy was also measured at 1.2 to 1.7 eV. (D.L.C.)

Moessbauer Effects and NMR

Refer also to abstracts 34042 and 34082.

33466 TIME-DIFFERENTIAL PERTURBED ANGULAR CORRELATIONS OF ^{160}Gd IMPLANTED INTO FERROMAGNETIC Gd AND OF ^{176}Yb INTO Fe AND Ni. Spehl, H.; Wertz, N. (Univ., Freiburg i. B.). Z. Phys.; 243: 431-400(1971).

Time-differential perturbed-angular-correlation measurements of ^{160}Gd in ferromagnetic Gd at various temperatures and of ^{176}Yb in Fe and Ni were performed following Coulomb excitation with a pulsed beam and recoil implantation. Using the theory of combined static magnetic and electric hyperfine interaction, the measured time spectra are reasonably well reproduced, the magnetic fields and electric-field gradients being in agreement with other works. A phase shift of the Larmor precession, however, points to anomalous hyperfine fields acting on the nuclei in a very short time interval after the beam pulse. (auth)

33467 MOESSBAUER EFFECT IN ^{61}Ni. Voronin, A. M.; Kaipov, D. K. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat.; No. 2, 28-31(Mar-Apr 1970). (In Russian).

The possibility of observation of the Moessbauer effect using gamma sources of different origin and different surroundings of the Moessbauer nuclei was studied. The isomeric shift of nickel oxide relative to metallic nickel is $\delta = (-0.6 \pm 0.2)$ mm/second. (tr-auth)

33468 APPARATUS FOR MAGNETIC MEASUREMENTS AT HIGH PRESSURE. Vaughan, R. W. (California Inst. of Tech., Pasadena); Lai, C. F.; Elleman, D. D. Rev. Sci. Instrum.; 42: 626-9(May 1971).

A nonmagnetic high pressure cell capable of being used for a variety of magnetic measurements to over 100 kilobars is described. It is a Bridgman anvil type of cell that has a 3 to 5 mm^3 sample volume and is suitable for both pulsed and wide-line nuclear magnetic resonance (NMR) measurements. In addition to a detailed description of the apparatus used for wide line NMR measurements, the use of the high-pressure cell for magnetoresistance and susceptibility measurements is described. (auth)

33469 SENSITIVITY OF MARGINAL OSCILLATOR SPECTROMETERS. Adler, Michael S.; Senturia, Stephen D.; Hewes, C. Robert (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instrum.; 42: 704-12(May 1971).

A linearized theory for the signal and noise characteristics of a marginal oscillator NMR spectrometer was developed. The model modifies Watkins' theory to include the mixing of 1/f noise into the oscillator passband. Signal response, noise spectrum, signal-to-noise ratio, and noise figure are all calculated and compared with accurately calibrated experimental data. The calculated signal response (absolute) is within 12% of experiment. The results show that there are two distinct regions of spectrometer operation, one in which the noise spectrum is white and one in which the noise spectrum is dominated by 1/f mixer noise. In the region of predominately white noise, the calculated noise factor is 2.9 compared with the experimental value of 3.3. Guidelines for optimum selection of rf level and modulation frequency are presented. (auth)

33470 INFLUENCE OF LOCALIZED RARE-EARTH MOMENTS ON ^{45}Sc NUCLEAR MAGNETIC RELAXATION. Fradin, F. Y. (Argonne National Lab., Ill.). Phys. Rev. Lett.; 26: 1033-6(26 Apr 1971).

Scandium-base alloys of 0.02 and 0.05 at. % of gadolinium and dysprosium were studied using transient nuclear-magnetic-resonance techniques. The ^{45}Sc nuclear spin–lattice relaxation rate is enhanced in the rare-earth alloys. For $1.6 \leq T \leq 4.2$°K, the relaxation rate is described by $1/T_1 = (1/T_1)_{Sc}[1 + KB_J(x)/H]$, where $(1/T_1)_{Sc}$ is the pure scandium relaxation rate, K is a constant, and $B_J(x)$ is the Brillouin function for $x \equiv gJ\mu_B H/k_B T$. The T_1 results are explained in terms of enhanced nuclear relaxation due to virtual excitation of the rare-earth magnetic moments. (auth)

33471 ANOMALOUS NUCLEAR RESONANCE BEHAVIOUR OF ^{59}Co IN $GdCo_2$. Brown, G.; Issa, M. A. A.; Taylor, K. N. R. J. Phys., F (London); 1: L10-12(Mar 1971).

Spin-echo measurements of the ^{59}Co nuclear resonance in $GdCo_2$ revealed a rapid decay of the spin-echo amplitude with temperature up to 40°K followed by a further growth up to 79°K and subsequent decay above this temperature. (auth)

33472 ANISOTROPIC BEHAVIOR OF DILUTE SCANDIUM–GADOLINIUM ALLOYS. Salamon, M. B. (Univ. of Illinois, Urbana). Phys. Rev. Lett.; 26: 704-7(22 Mar 1971).

The g value for electron spin resonance of Gd impurities in Sc is found to be anisotropic. The anisotropy is shown to result from spin–orbit coupling in the impurity cell. (auth)

33473 FET MARGINAL OSCILLATOR CIRCUIT. Idoine, John D. Jr.; Brandenberger, J. R. (Lawrence Univ., Appleton, Wis.). Rev. Sci. Instrum.; 42: 715-7(May 1971).

A marginal oscillator based on the Franklin configuration that utilizes field effect transistors and integrated circuits is described. The marginal oscillator can be used as an NMR spectrometer, a magnetometer, or a magnetic field stabilizer. A circuit diagram is given, and the performance is summarized. (W.H.K.)

33474 ACOUSTIC NUCLEAR MAGNETIC RESONANCE IN METALS. Baily, Philip Kent. Los Angeles; Univ. of California (1970). 88p. University Microfilms Order No. 71-9210. Thesis.

Using the acoustic magnetic resonance technique, a new nuclear spin–phonon interaction mechanism was observed. In the presence of a large dc magnetic field, an ultrasonic wave in a metal induces an oscillatory magnetic field at the ultrasonic frequency, and this field can induce nuclear Zeeman transitions. This magnetic interaction allows acoustic excitation of true nuclear magnetic resonance. This effect was observed in single crystals of aluminum and vanadium. The acoustic nuclear magnetic resonance signal was observed for transverse and longitudinal ultrasonic waves in aluminum at 77 and at 300°K. The observed dependence of the signal strength upon the angle between the applied magnetic field and the acoustic propagation vector in aluminum agrees with theoretical predictions for all polarizations, allowing the positive identification of the coupling mechanism. Frequency-dependence measurements support this conclusion, and results in vanadium at 77 and at 4.2°K are similar to those in aluminum. The nuclear spin energy absorption also influences the ultrasonic attenuation due to Joule heating losses. This effect increases the magnitude of the observed resonance signal and introduces a dispersive component into the energy absorption. This is proposed as a possible explanation for the asymmetric line shape that is observed when the electromagnetic skin depth is not substantially smaller than the acoustic wavelength. (Diss. Abstr. Int., B)

Theory

33475 DYNAMIC ELECTRON–PHONON COUPLING FUNCTIONS. Coulthard, M. A. (Dalhousie Univ., Halifax, N. S.). J. Phys., F (London); 1: 188-94(Mar 1971).

The electron–phonon coupling function $\alpha^2(\nu)F(\nu)$ was calculated for the cubic simple metals Na, K, Al, and Pb, and the effects on the coupling strength of variations in the theoretical screened electron–ion potential were studied. The volume dependence of the coupling function was also determined using theoretical phonon frequencies. (auth) (UK)

33476 MANY-BODY FORMULATION OF FIELD EMISSION IN METALS. Leung, M. C. (Univ. of Saskatchewan, Regina, Can.). Phys. Lett.; 35A: No. 2, 126-7(17 May 1971).

Effective Hamiltonian approach and Green function formalism are employed to treat the many-body effects on field emission in metals. As examples of application, the field emission in superconductors and dilute magnetic alloys is considered. (auth)

33477 ROLE OF JAHN–TELLER EFFECT IN THE LIGAND FIELD THEORY OF OCTAHEDRALLY COORDINATED TRIS-ACETYLACETONATO MANGANESE. Bhattacharyya, B. D. (Indian Association for Cultivation of Science, Calcutta). Phys. Status Solidi (b); 43: No. 2, 495-503(1 Feb 1971).

A theoretical expression for the magnetic susceptibility and anisotropy of a Mn (III) ion having trigonal symmetry in octahedral

trisacetylacetonato manganese have been derived on the basis of the more general molecular orbital method of Van Vleck, Stevens, and Bose et al., considering quantum mechanical tunneling which links equivalent vibronic states of the Jahn–Teller ion. Attempts have been made to fit the experimental data of optical absorption and magnetic susceptibility with a unique set of parameters in the theoretical expressions at all temperatures. From this an estimate of the parameters which describe the Jahn–Teller potential is made. (auth)

Theoretical Physics

Refer also to abstracts 33501, 33807, and 33813.

33478 (ITEF–773) EXPONENTIAL DECAY LAW OF NONSTABLE PARTICLE. Terint'ev, M. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 67p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of time dependence of the probability of decay of unstable particle is studied. It is argued that in the framework of quantum mechanics the exponential decay law $\exp(-\gamma t)$ must be valid practically at any values of time t, or more precisely, the better the experimental setup, the further the exponential decay law may be seen. (auth)

33479 RELATIVISTIC BOHR FORMULA. Barut, A. O. (Univ. of Colorado, Boulder). Nature (London) Phys. Sci.; 230: 180(19 Apr 1971).

Reference is made to Synge (Nature 228: 271(1970)) who discussed a relativistic extension of the Bohr formula $h\nu' = E' - E$ for the frequency of the emitted light quantum between two levels of a quantum system. The equations obtained were purely kinematic and formal. The present communication is concerned with the explicit evaluation of these equations. There is a new version of the dynamics of the H atom that includes recoil effects to all orders; in this version the atom is treated as a whole as a single relativistic system with internal degrees of freedom. The recoil effects are small for the H atom but are of considerable importance in other systems, such as nuclei, hadrons, exotic atoms, etc. In particular, the derived equations are valid for $Z\alpha \geq 1$; this is the case for the atom formed out of spinless particles having both electric and magnetic charges and known as dyonium. (UK)

33480 PATH INTEGRALS AND PRODUCT INTEGRALS. Hamilton, John F. Jr.; Schulman, L. S. (Indiana Univ., Bloomington). J. Math. Phys. (N. Y.); 12: 160-4(Jan 1971).

The product integral is shown to be the appropriate mathematical tool for implementing the path integral for spin in its simplest form. (auth)

33481 CRITERIA OF THERMAL (OVERHEAT) INSTABILITY OF A TRANSPARENT RADIATING GAS. Getling, A. V.; Kuz'min, V. V.; Tverskoi, B. A. (Moscow State Univ.). Dokl. Akad. Nauk SSSR; 196: 71-4(1 Jan 1971). (In Russian).

A gas heated by a nonradiative process and emitting energy by radiation may be unstable with respect to small perturbations of its thermodynamic parameters. This effect may be observed under various astrophysical conditions. A system of gas dynamic equations was used to derive a generalized criterion of thermal stability, taking into account the difference of released and radiated energy on the basis of a certain function Q of the thermodynamic state of the gas. This was further examined under the assumption that the gas is transparent and there is no radiative thermal-conductivity-type heat transfer of the order of the perturbation wave length, and the viscosity and molecular kinetic heat conductivity may be neglected. In a second part of the work, it was assumed that the gas has a high conductivity and is placed within an external magnetic field. The applicability and limitations of the derived formulas are given. (TTT)

33482 APPLICATION OF CONTINUAL INTEGRATION TO THE DEDUCTION OF LOW-FREQUENCY ASYMPTOTICS OF GREEN FUNCTIONS AND KINETIC EQUATIONS FOR NONIDEAL BOSE GAS. Popov, V. N. (Mathematical Inst., Moscow). Teor. Mat. Fiz.; 6: 90-108(Jan 1971). (In Russian).

Perturbation theory formalism is developed that makes it possible to calculate the Green functions of a nonideal Bose gas at small energies and momenta (in the hydrodynamical region) below the Bose-condensation point. The continual integration method is used for pointing out the perturbation theory diagrams, which give the main contribution into the hydrodynamical asymptotics of Green functions. It is shown that the summation of the diagrams chosen is reduced to the solution of kinetic-type equations. The solution of these equations by the Chapman–Enskog–Hilbert method gives, in the first approximation, the Green functions corresponding to first and second sound. The second approximation allows one to express the damping in terms of kinetic coefficients of the first and second viscosity and thermal conductivity. These coefficients are determined by the collision integral, which can be obtained automatically by the summation of diagrams. (auth)

33483 VARIATIONAL ANALYSIS ON THE GROUND STATE OF A CHARGED-BOSON SYSTEM. Lee, Deok Kyo (Univ. of Kansas, Lawrence. Univ. of California, Berkeley). Phys. Rev., A; 2: 278-84(Aug 1970).

The ground state of a charged-boson system is studied throughout the entire density range in a variational formalism based on the correlated wave functions. The expectation value of the Hamiltonian operator H is evaluated in the hypernetted-chain approximation using a simple trial radial distribution function which contains three variational parameters. The resulting ground-state energies are found to be higher than the exact values by 0.05 and 7.5% at high- and low-density limits, respectively. At the intermediate densities ($0.01 \leq r_s \leq 100$), the ground-state energies computed numerically lie slightly below the known results. It is conjectured, but not proved, that the extremum values of $\langle H \rangle$ obtained in the present analysis are upper bounds to the exact ground-state eigenvalues. (auth)

33484 DENSITY CORRELATIONS IN A MANY PARTICLE SYSTEM. Wu, F. Y. (Northeastern Univ., Boston). Phys. Lett.; 34A: 446-7(19 Apr 1971).

The multiple density correlation function $\langle \rho k_1 \rho k_2 \ldots \rho k_n \rangle$ of a many-particle system is evaluated, using the convolution approximation for the n-particle distribution function. (auth)

33485 EFFECTS OF ELECTRIC AND MAGNETIC DIPOLE MOMENTS ON VAVILOV–CHERENKOV RADIATION IN A GYROTROPIC MEDIUM. Kukanov, A. B.; Burlakov, V. I. (Moscow State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 11, 109-15 (1970). (In Russian).

An expression was developed for the integral of energy loss of Vavilov–Cherenkov radiation in a uniaxial gyrotropic crystal by a neutral particle, the latter possessing electric and magnetic dipole moments. Further, the expression applies to the special case where the particle is moving at an angle to the optic axis. Other cases were examined wherein integration of the wave numbers in space may be performed with analytical accuracy. (tr-auth)

33486 STATISTICAL GROUP THEORY AND THE DISTRIBUTION OF ANGULAR MOMENTUM STATES. Cleary, J. G.; Wybourne, B. G. (Univ. of Canterbury, Christchurch, N. Z.). J. Math. Phys. (N. Y.); 12: 45-52(Jan 1971).

The problem of developing relations for the statistical distribution of the angular momentum states of an electron configuration l^N, where l and N are large, was considered. If D(L) is the number of times the orbital angular momentum L occurs, then, using the theory of partitions and groups, it is found that the numbers D(L) are approximately distributed with respect to L according to the Wigner-type form $D(L) = A(L + \frac{1}{2}) \exp[-(L + \frac{1}{2})^2/2\sigma^2]$. A number of examples are examined. (auth)

33487 NONADIABATIC MOTION OF PARTICLES INCLUDING DISSIPATION. Krivets, V. P. (Physical-Technical Inst., Leningrad); Peregood, B. P.; Wilhelmsson, H. Phys. Scr.; 2: 116(1970).

The influence of dissipation on the motion of charged particles rapidly increasing uniform magnetic fields is considered for axisymmetric situations. A dissipative term, linear in the magnetic field intensity, is found not to destroy the result that all particles simultaneously reach the axis of symmetry. This conclusion is valid provided the characteristic relaxation time is long compared to the time needed for the magnetic field to reach asymptotically its extreme values in the absence of dissipation. (auth) (Sweden)

33488 STIMULATED EMISSION OF BREMSSTRAHLUNG IN A PERIODIC MAGNETIC FIELD. Madey, John M. J. (Stanford Univ., Calif.). J. Appl. Phys.; 42: 1906-13(Apr 1971).

The Weizsäcker–Williams method is used to calculate the gain due to the induced emission of radiation into a single electromagnetic mode parallel to the motion of a relativistic electron through a periodic transverse dc magnetic field. Finite gain is available from the far-infrared through the visible region raising the possibility of continuously tunable amplifiers and oscillators at these frequencies with the further possibility of partially coherent radiation sources in the ultraviolet and x-ray regions to beyond 10 keV. Several numerical examples are considered. (auth)

33489 RESONANT AND NONRESONANT ENERGY GAIN OF A CHARGED PARTICLE IN A MODULATED ELECTROMAG-

XUM

NETIC FIELD. Airoldi Crescentini, A.; Pozzoli, R. (CNR, Milan). Phys. Lett.; 34A: 258-9(22 Mar 1971).

The possibility of energy transfer to a charged particle, in a static magnetic field, by a modulated electromagnetic field is investigated. The existence of a resonant and a nonresonant mechanism for the energy gain is found. (auth)

33490 SCATTERING OF TWO QUASI PARTICLES. Razavy, M.; Binder, M. (Univ. of Alberta, Edmonton). Can. J. Phys.: 49: 501-7(1 Mar 1971).

For a system of many bosons, quasi particles are defined as simple excitations having energies equal to those predicted by the Bogolyubov and Valatin–Butler theories. Scattering between these elementary excitations is caused by the residual interaction. This results in a change in the energies of quasi particles and a finite lifetime for the excitations. The force between two quasi particles is determined in terms of the boson–boson potential, and the distribution function for different excitations. Perturbed single-particle energies are also calculated within the framework of the reaction matrix. (auth) (Canada)

33491 ENERGY OF INTERACTION BETWEEN NEUTRAL ATOMS IN AN EXTERNAL MAGNETIC FIELD. Tulub, A. V.; Bal'makov, M. D.; Khallaf, A. S. (Leningrad State Univ.). Dokl. Akad. Nauk SSSR; 196: 75-7(1 Jan 1971). (In Russian).

The energy of interaction of two neutral atoms located far from each other in an external electric field with a potential of E is studied, disregarding the delayed effects, and assuming that the ground state of each atom is spherically symmetric. An attempt is made to determine the energy of interaction, averaged according to all of the possible orientations of the internuclear axis with respect to the direction of the external electric field. A second approximation, based on the perturbation theory, is derived to describe the interatomic interaction by the dipole–dipole potential. The expression obtained includes a term based on E and the internuclear distance R, which may be also related to nonadditive terms in the expression concerning the polarizability of the interacting system. The coefficient α in the $\alpha E^2/R^6$ expression is calculated because its value has not been determined previously even for such a simple case. The final expression including the Van der Waals constant for two hydrogen atoms in the atomic system of units is derived as: $\Delta E = (6.499026 + 849E^2)/R^6$. (TTT)

33492 COLLECTIVE EXCITATIONS. Evans, J. A.; Turner, R. E. (Univ. of Sussex, Eng.). Phys. Bull. (London); 22: 88-91(Feb 1971).

It is shown how cooperative particle excitations lead to collective oscillations of a many-particle system. The underlying theory is the same in all cases and gives rise to a dispersion formula for the natural frequencies of the system. In extended systems, the dominant feature determining the type of solution obtained is the range of the interactions. (auth) (UK)

33493 STRUCTURE FACTOR AND EXCITATION SPECTRUM OF THE MANY-BODY SYSTEM CALCULATED BY THE DECOUPLING OF GREEN FUNCTIONS. Parlinski, K. (Inst. of Nuclear Physics, Krakow). Physica; 51: 299-310(29 Jan 1971).

Using the method of retarded Green functions, the system of self-consistent equations for radial distribution functions and the excitation spectrum of a many-body system are found. The simplest approximation is used in which the elementary excitations are not damped. The Feynman relation for the structure factor and the Hubbard–Beeby formulas of the self-energy spectrum of collective excitations in liquids are involved in this system. Properties of the classical and quantum liquids are described qualitatively. (auth)

33494 NONANALYTICITY OF THE S-MATRIX IN MANY-BODY THEORY. Binder, M.; Razavy, M. (Univ. of Alberta, Edmonton). Phys. Lett.; 34A: 374(19 Apr 1971).

For a model Hamiltonian consisting of quasi-particle energies and pairing forces, the S-matrix is shown to be a nonanalytic function of the coupling constant for an arbitrary number of quasi particles. (auth)

33495 TIME–ENERGY INDETERMINACY RELATIONSHIP. Fujiwara, Izuru (Univ. of Osaka Prefecture, Sakai, Japan). Progr. Theor. Phys. (Kyoto); 44: 1701-3(Dec 1970).

The validity of the time–energy relation $\Delta t \cdot \Delta E \geq \hbar/2$ is discussed. Brief arguments are given to show that the relation is actually deducible from the principles of the quantum theory in conformity with the so-called metatheorem. (M.O.W.)

33496 APPROXIMATE ANALYTIC EIGENVALUES OF LENNARD-JONES POTENTIALS. Eu, Byung Chan; Guerin, Herve (McGill Univ., Montreal). Can. J. Phys.; 49: 486-92 (15 Feb 1971).

Approximate analytic expressions of eigenvalues for Lennard-Jones (10,6) and (12,6) potentials are obtained. The eigenvalues obtained from such expressions are compared with the WKB or numerical eigenvalues for the estimation of accuracy. (auth) (Canada)

33497 COHERENT EXCITATION BY A MODULATED PARTICLE BEAM. Favro, L. D.; Fradkin, D. M.; Kuo, P. K. (Wayne State Univ., Detroit). Lett. Nuovo Cim.; 4: 1147-50 (12 Dec 1970).

It has recently been shown by Schwarz and Hora (Appl. Phys. Lett., 15: 349(1969)) that an electron beam which has been modulated by a laser can emit monochromatic radiation at the laser frequency during a subsequent scattering process. The laser has the effect of stimulating the emission and absorption of photons by individual electrons in the beam in such a way that there are phase correlations from electron to electron. The Schwarz–Hora effect is but one example of a whole class of unusual effects. These effects can arise in the scattering of any beam whose treatment has been such as to introduce particle–particle phase correlations into the state of the beam. A general theoretical derivation of the contribution to a transition probability due to such correlations is given. (M.O.W.)

33498 THEORY OF TRANSITION RADIATION IN AN OBLIQUE PASSAGE OF A CHARGED PARTICLE THROUGH A PLATE AND A STACK OF PLATES. Arakelyan, V. A.; Garibyan, G. M. (Inst. of Radio Physics and Electronics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 320-37(1970). (In Russian).

Transition radiation fields, produced in an oblique passage of a charged particle through the interface of the media, a plate and a stack of plates, are obtained. The formulas derived are of a relatively simple form and are easily interpreted. (M.O.W.)

33499 THEORY OF FORMATION OF TRANSITION X-RAY RADIATION IN A STACK OF PLATES. Garibyan, B. M. Zh. Eksp. Teor. Fiz.; 60: 39-52(Jan 1971). (In Russian).

The formation of transition radiation in the transoptical frequency range during traversal of a plate stack by an extremely relativistic particle is analyzed theoretically. It is shown that the radiation is described by various formulas depending on the specific physical conditions. The frequencies corresponding to radiation peaks are found, and the influence of the stack on the formation of radiation in a plate is investigated. Some results of numerical calculations of the transition-radiation quanta spectral distribution are also presented. The problem of the possible effect of multiple scattering on the distributions is briefly considered. (auth)

33500 SELF-CONSISTENT FIELD CALCULATION OF ELECTRON INTERACTION ENERGY. Anderson, J. T. (Queens Coll., Flushing, N. Y.). Nuovo Cim.; 1B: 100-10(11 Feb 1971).

The interaction energy of electrons in a finite-temperature electron gas with scalar interactions is obtained on the complex energy plane. For Coulomb interactions the ground-state result is in agreement with earlier calculations but, at finite temperature, an additional temperature-dependent term appears in the short-range correlation energy. (auth)

33501 APPLICATION OF SECOND ORDER APPROXIMATIONS FOR THE GREEN'S FUNCTION. Fuchssteiner, B. (Technische Hochschule, Darmstadt, Ger.). Z. Phys.; 240: 17-29(1970).

In a previous paper (Beck and Fuchssteiner, Z. Physik, 239: 276(1970)) an approximation theory was developed for the Green's functions that gives approximations consistent with the conservation laws of the Hamiltonian. A concept of reduction was chosen that is different and that leads to other approximations for the particle–hole Green's function than the usual concept of reduction. The particle–hole Green's function is the function $\langle\Psi_0|\tau\{a_1^+(0)a_2(0)a_3^+(t)a_4(t)\}|\Psi_0\rangle$ where $|\Psi_0\rangle$ is the real ground state and τ stands for the time-ordered products of the operators. An example of an application of this theory is given. (auth)

33502 PERTURBATION SERIES IN OPERATOR AND SUPER-OPERATOR FORMALISM. I. Turner, J. W. (Univ. Libre, Brussels). Physica; 51: 351-64(15 Feb 1971).

In recent work of Prigogine et al., a generalized transformation theory in terms of superoperators was developed. In the case of nondissipative systems, i.e., systems such that all transitions have a finite nonvanishing energy, this theory should reduce to the usual unitary transformations of quantum mechanics. The equation for the transformation superoperator χ^{-1} is solved in the form of a series, which is then compared in the nondissipative case to the Wigner–Brillouin perturbation series. The two series, although highly dissimilar at first sight, are nevertheless shown to be equivalent. (auth)

33503 VECTOR BUNDLES IN MATHEMATICAL PHYSICS. VOLUME II. APPLICATIONS TO QUANTUM MECHANICS. Hermann, Robert. Mathematics Lecture Note Series. New York; W. A. Benjamin, Inc. (1970). 410p.

The topics covered include the notations of finite- and infinite-dimensional manifold, the contact and canonical structure on the cotangent bundle, some basic theorems on Lie algebra theory, the homology and cohomology of manifolds, and canonical quantization rules and differential operators. Also discussed are the symbol of a linear differential operator and its physical applications, the transition, classical and quantum dynamical systems of homogeneous spaces, and the invariance of the Schroedinger equation. (J.F.P.)

33504 INDUCED RADIATION OF ELECTRONS IN AN AXIALLY SYMMETRIC ELECTROSTATIC FIELD. Selimov, B. K. (Dagestan State Univ., Makhachkala, USSR). Izv. Vyssh. Ucheb. Zaved., Radiofiz.; 14: No. 1, 152-6(1971). (In Russian).

The induced radiation and absorption of electrons spiraling in an inhomogeneous electrostatic field are considered. The effect is discovered of the prevalence of radiation over absorption at one of the natural frequencies of the electron motion analogous to that for a homogeneous magnetic field. (auth)

33505 WENTZEL–KRAMERS–BRILLOUIN APPROXIMATION IN THE SCATTERING BY A SINGULAR POTENTIAL. Cao-Xuan-Chuan; Ho-Van-Hoa (Faculte des Sciences, Saigon, South Vietnam). Compt. Rend., Ser. B; 271: No. 17, 873-6(28 Oct 1970). (In French).

Previous results obtained in the framework of classical mechanics are extended to semi-quantum mechanics. (France)

33506 MODERN PHYSICAL THEORY. SPECIAL RELATIVITY AND QUANTUM PHYSICS. Sanders, Timothy D. Addison-Wesley Series in Physics. Reading, Mass.; Addison-Wesley Publishing Company, Inc. (1970). 599p. $16.95.

A unified view is given of the central theories of modern physics, with special emphasis on their relationships with classical electromagnetic theory rather than those with classical mechanics. The emphasis is on mathematical formulation of fundamental ideas, together with illustrative calculations to show how the theory is used in obtaining quantities that can be checked against experiment, thereby demonstrating that the theory is believable. In the early chapters, special relativity and its tensor formulation are developed from the crucial and well-known Gedenken experiment. The tensor formulation of electromagnetism is developed as an application of the theory, and in particular the energy and momentum densities of the electromagnetic field are obtained from the four-dimensional formulation. This leads naturally to a consideration of Planck's law and the experimental foundations of quantum theory. Fourier analysis of wave phenomenon introduces the mathematics of quantum mechanics, including state vector language. The relationships between symmetries and quantum numbers are stressed. Perturbation theory and collision theory are included as applications. (auth)

33507 ESTIMATES OF VARIANCE AND MERIT RATIOS FROM MEASURED QUANTITITES OF FLUCTUATING ORIGIN AND INHERENT CORRELATION. De Volpi, A. (Argonne National Lab., Ill.). Int. J. Appl. Radiat. Isotop.; 22: 103-10 (Feb 1971).

The origin of variances estimated for quantities based on measured numbers arising from natural processes is examined. If the data are accumulated in joint time intervals, it is frequently necessary to take into account statistical correlation. In so doing the status of a number of formulae applied as guidelines for counting time ratios, figures of merit, and coincidence counting are reviewed with some extensions being developed. Also, a new application, that of calibration of the duration of a digital gate or delay, is introduced. The formula developed for universal evaluation of the merit ratio for two counting systems is independent of counting time allocations, as desired. The limiting conditions for relatively low and relatively high signal/background ratios are applied—established expressions are obtained. The optimum counting-time ratio for a decaying source is derived, a result which could be applied to explicit determination of a merit ratio for two systems measuring rapidly decaying sources. The expression developed for estimation of error in the gate duration measurement justifies the relatively small statistical spread observed in the actual delay calibration procedure. (auth) (UK)

33508 UTILIZATION OF TWO-TIME TEMPERATURE FORMALISM FOR STUDYING QUASIPARTICLE EXCITATIONS OF HIGH DENSITY FERMI-GAS SYSTEMS. Ozrin, V. D. Vestn. Mosk. Univ., Ser. III. Fiz. Astron.; No. 6, 9-18 (Nov-Dec 1968). (In Russian).

Green's two-time temperature functions were used in studies of Coulomb interaction system. The suggested uncoupling procedure produced the expression for the mass operator and a single-particle Green's function. Spectra for single-particle excitations of the system and thermodynamic potential for high and low temperatures were obtained by means of Green's functions. (tr-auth)

33509 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON ATOMIC, MOLECULAR, AND SOLID-STATE THEORY AND QUANTUM BIOLOGY, HELD AT SANIBEL ISLAND, FLORIDA, JANUARY 13–18, 1969. PART 1. Loewdin, Per-Olov (ed.). Int. J. Quant. Chem., Symp.; No. 3, 1-348(1969). (CONF-690120-(Pt.1)).

Thirty-four papers are included in this volume from the quantum chemistry and theory conference, which was dedicated to Henry Eyring. (D.L.C.)

33510 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON ATOMIC, MOLECULAR, AND SOLID-STATE THEORY AND QUANTUM BIOLOGY, HELD AT SANIBEL ISLAND, FLORIDA, JANUARY 13–18, 1969. PART 2. Loewdin, Per-Olov (ed.). Int. J. Quant. Chem., Symp.; No. 3, 349-910(1970). (CONF-690120-(Pt.2)).

Fifty-four papers are presented in this volume from the quantum chemistry and theory conference. Some of the topics treated are: atomic theory, correlation, molecular properties, Hartree–Fock theory and energies, spin, electron band structures, antiferromagnetism, etc. (D.L.C.)

33511 THREE-BODY PROBLEM IN QUANTUM MECHANICS. II. CASE OF TWO NEUTRONS AND A HEAVY NUCLEUS. Cikhovskii, V. S. (Univ., Milan, Kiev State Univ.). Lett. Nuovo Cim.; 1: No. 18, 753-7(1 May 1971).

The integral equations for the wave function and the transition matrix in the system of two neutrons and a heavy nucleus are presented. The algebraization procedure is shown. (M.H.R.)

33512 THREE-BODY PROBLEM IN QUANTUM MECHANICS. III. CASE OF POTENTIALS WITH HARD CORES. Cikhovskii, V. S. (Univ., Milan, Kiev State Univ.). Lett. Nuovo Cim.; 1: No. 18, 758(1 May 1971).

The necessary changes and re-definitions for dealing with the case of two-particle potentials with hard cores are shown. (M.H.R.)

33513 PARADOX OF QUANTUM-RELATIVISTIC ELECTRON VIBRATIONS. Sofonea, Liviu. Bul. Inst. Politeh. Brasov, Ser. B; 11: 45-56(1969). (In Rumanian).

The kinematic and dynamic properties of an electron in free motion and described by Dirac equation are analyzed. The necessary existence of an oscillatory motion superposed on a translational motion is explained, and some interpretations are given. (auth)

33514 NEW MAGNETIC FIELD FOR DIRAC'S EQUATIONS. Hautot, A. (Univ., Liege). Phys. Lett.; 35A: No. 2, 129-30 (17 May 1971).

Dirac's equations are exactly solvable for a magnetic field that seems to have never been considered. Energy levels are given. (auth)

33515 CORRESPONDENCE PRINCIPLE. Fay, G. (London Univ.). Acta Phys. Acad. Sci. Hung.; 29: No. 2-3, 167-81(1970).

Several concepts of possible "correspondences" between quantum and classical mechanics are defined and examined in what cases they can be satisfied. (auth)

XUM

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 33583 and 33584.

Electromagnetic

Refer also to abstracts 33629, 33645, 33646, and 33933.

33516 (INP-713(Vol.2), pp 49-54) SINGLE PION PHOTOPRODUCTION IN THE RESONANCE REGION W = 1-2 GeV. Karl, Gabriel (Guelph Univ. (Ontario). Dept. of Physics).

The qualitative features of the experimental data in a previous review of single pion photoproduction in the resonance region are briefly summarized. Also quark model calculations are presented in some detail. (J.F.P.)

33517 (NYO-4115-1) PHOTOPRODUCTION OF PIONS WITH POLARIZED PHOTONS. Technical Progress Report. Bar-Yam, Z.; de Pagter, J.; Dowd, J.; Kern, W.; Russell, J. (Southeastern Massachusetts Univ., North Dartmouth). 22 Feb 1971. Contract AT(30-1)-4115. 65p. Dep. NTIS.

Results of an extended study on the photoproduction of pions with polarized photons are presented and discussed. The study includes a series of experiments conducted at the Cambridge Electron Accelerator covering a large range of photon energies and momentum transfers and involving all charge states of the pion. (auth)

33518 NEW MEASUREMENT OF THE MAGNETIC MOMENT OF THE Λ-HYPERON. Dahl-Jensen, E. (CERN, Geneva); Doble, N.; Evans, D.; (and others). Nuovo Cim.; 3A: 1-24(1 May 1971).

The magnetic moment of the Λ-hyperon was measured by observing the precession of the polarization vector of Λ-particles in a transverse pulsed magnetic field of 20 T (= 200 kG). The hyperons were produced in a polyethylene target by the reaction $\pi^- + p \rightarrow \Lambda + K^0$ at a pion momentum of 1.05 GeV/c; their decays were detected in stacks of nuclear emulsion at a distance of 11 cm from the centre of the target. (auth)

33519 ON POSSIBILITY OF STUDYING RESONANCES WITH POSITIVE CHARGE PARITY IN COLLIDING ELECTRON-POSITRON BEAMS. Vainshtein, A. I.; Khriplovich, I. B. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: 620-3(Mar 1971). (In Russian).

A possibility is discussed of studying in colliding electron-positron experiments the resonances with positive charge parity which may be produced via two-photon intermediate state. The estimates show that the charge asymmetry in the angular distribution for reaction $e^+e^- \rightarrow \pi^+\pi^-$ at the total energy equal to the f-meson mass may achieve 20%. (auth)

33520 ρ PRODUCTION IN DEEP-INELASTIC ELECTRON SCATTERING. Andrews, D. E. (Cornell Univ., Ithaca, N. Y.); Berkelman, K.; Cassel, D. G.; (and others). Phys. Rev. Lett; 26: 864-6(5 Apr 1971).

The reaction $e + p \rightarrow e + p + p^0$ is measured by observing electron-proton coincidences for ν beyond the resonance region and for $-t = 0.07$ to 0.5 GeV^2. It is noted that the yield of $p + p^0$ relative to other hadron final states is less than in photoproduction. (auth)

33521 LOW-ENERGY PHYSICS FROM A HIGH-ENERGY STANDPOINT. Jain, P. L.; Stern, Angela (State Univ. of New York, Buffalo). Phys. Rev. Lett.; 26: 980-3(19 Apr 1971).

Interaction of 10.1- and 15.8-GeV/c positive and negative muons with nuclear emulsion nuclei is studied for events with one gray or black prong in addition to the outgoing muon track. The events involving very low energy exchange are consistent with "giant dipole" resonance. The line shape, its width, and the cross section of this resonance is discussed, as well as the angular distribution of the low-energy protons. (auth)

33522 PRODUCTION OF ELECTRON PAIRS FROM A ZERO-MASS STATE. Reiss, Howard R. (American Univ., Washington, D. C.). Phys. Rev. Lett.; 26: 1072-5(26 Apr 1971).

Results are presented for the production of electron pairs by the collision of high-energy bremsstrahlung and high-intensity laser beams. With Stanford linear accelerator bremsstrahlung parameters, it is found that the laser must be focused to about 10^{18} W/cm^2 to produce pairs. Approximately 25 laser photons participate in each event, and the required laser intensity is outside the known radius of convergence of perturbation theory for this process. The electron mass shift may also be determined. (auth)

33523 EXPERIMENTAL STUDY OF THE π^0 MESON PHOTOPRODUCTION ON HYDROGEN IN THE ENERGY RANGE OF THE FIRST PION-NUCLEON RESONANCE. Morand, Rene (Univ. Strasbourg). Ann. Phys. (Paris); 5: No. 3, 203-26(May-Jun 1970). (In French).

The differential cross section for single π^0 photoproduction from hydrogen was measured at angles 70, 90, 130, and 175° for photon energies from 220 to 400 MeV by detecting the recoil protons. The experimental results were fitted with second degree polynomials in cos teta and compared to the available experimental data. From the theoretical point of view the 175° results emphasize the importance from the multipolar contributions $E^{\frac{3}{2}}_{1+}$, $M^{\frac{3}{2}}_{1+}$, and ReE_{0+}. These contributions were fitted to the experimental results in the framework of fixed t dispersion relation. The available experimental data are compared to the most recent theoretical approaches. (France)

Weak

Refer also to abstracts 32271 and 33667.

33524 (COO-1701-14) EXPERIMENTAL STUDY OF THE BETA DECAY OF POLARIZED LAMBDA HYPERONS. Watson, Jerry Mike (Chicago Univ., Ill.). [1970]. Contract AT(11-1)-1701. 106p. (EFI-71-22). Dep. NTIS.

A study is made of the form of the weak interaction in the beta decay of the lambda hyperon $\Lambda \rightarrow p + e^- + \bar{\nu}$. The resulting distributions are shown, including mass, momentum, and lifetime. The spin correlations are given. (J.F.P.)

33525 (UCRL-20031) THE BRANCHING RATIO $K \rightarrow e\nu/K \rightarrow \mu\nu$: A TEST OF V-A THEORY OF WEAK INTERACTIONS. McReynolds, John Frederick (California Univ., Berkeley. Lawrence Radiation Lab.). 16 Sep 1970. Contract W-7405-eng-48. 86p. Dep. NTIS.

Thesis.

An optical spark chamber experiment utilizing an axially focusing cylindrically symmetric spectrometer has gathered 62.6 ± 11 $K \rightarrow e\nu$ events, giving a branching ratio $Ke_2\ K\mu_2 = 2.32 \pm 0.39 \times 10^{-5}$, and setting new limits of

$$0 \leq \left|\frac{f_P}{f_A}\right| < 1.75 \times 10^{-4} \quad \text{or} \quad 1.82 \times 10^{-3} < \left|\frac{f_P}{f_A}\right| < 2.12 \times 10^{-3}$$

A beam of 500 K^+/pulse with $K^+/\pi^+ = 0.002$ from the Bevatron external proton beam was stopped on the spectrometer axis. Charged particles over 0.4 of 4π were allowed a single orbit in the spectrometer. Such particles in a 12% momentum bite passed through a 300 psi ethane Cherenkov counter, a scintillator and spark chamber array designed for ±1% momentum analysis, and into a lead cylinder, spark chamber, and scintillator array designed for muon rejection. Events were scanned and measured on SASS, an automatic scanning system. A total of 150,000 events were measured, analyzed, and kinematically reconstructed. These events satisfied trigger requirements for Ke_2, for $K \rightarrow$ charged particle + γ, and for normalization to $K\mu_2$, $K\pi_2$, and Ke_3. (auth)

33526 DETECTION OF RHO-MESONS PRODUCED BY MUON-NUCLEI INTERACTIONS. Konishi, S.; Ochiai, F.; Okabe, H.; Wada, T. (Osaka City Univ.). Lett. Nuovo Cim.; 1: 691-4(24 Apr 1971).

Some rho meson production events were obtained from an exposure of emulsion stacks to 4.9- to 15.9-GeV/c muons. A new method which involves a subtraction of azimuthal angles is used to show the presence of the diffractively produced rho mesons from an examination of charged pion pairs. (J.F.P.)

33527 β DECAY OF THE Λ HYPERON. Canter, J. (State Univ. of New York, Stony Brook. Brookhaven National Lab., Upton, N. Y.): Cole, J.; Lee-Franzini, J.; (and others). Phys. Rev. Lett.; 26: 868-70(5 Apr 1971).

A sample of 141 kinematically determined $\Lambda \rightarrow pe\nu$ events was obtained. The internal-variable distribution for these events was used to determine the magnitude of the ratio of the coupling

constants, $|g_A/g_V| = 0.75^{+0.08}_{-0.11}$. The branching ratio was also obtained as $(0.78 \pm 0.09) \times 10^{-3}$. (auth)

33528 SEARCH FOR $\pi^+ \rightarrow e^+ + \nu e + e^+ + e^-$ DECAY. Korenchenko, S. M.; Kostin, B. F.; Mitsel'makher, G. V.; Nekrasov, K. G.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 339-40(Feb 1971). (In Russian).

The decay $\pi^+ \rightarrow e^+ + \nu e + e^+ + e^-$ was searched by using a cylindrical spark chamber placed into magnetic field. It was found that $W(\pi^+ \rightarrow e^+ + \nu e + e^+ + e^-)/W(\pi^+ \rightarrow \mu^+ + \nu_\mu) \leq 3.4(10)^{-8}$ with the 90% confidence level. (auth)

33529 POSSIBLE EXISTENCE OF CHARGED HEAVY LEPTONS. Ramm, C. A. (European Organization for Nuclear Research, Geneva). Nature (London) Phys. Sci.; 230: No. 15, 145-9 (12 Apr 1971).

The distributions of the invariant mass ($M_{\mu\gamma}$) calculated from muons and γ-rays originating at the vertex of ν interactions, and also from inelastic muon scattering, have enhancements in the mass range $0.422 < M_{\mu\gamma} < 0.437$ GeV. These enhancements are compatible with the possible existence of a short-lived charged heavy lepton ($M^*_{\mu\gamma}$) with the decay mode $M^*_{\mu\gamma} \rightarrow \mu + \gamma$. Such particles could be analogous to the neutral heavy leptons for which there is some evidence in the same mass range. (auth) (UK)

33530 FORM FACTORS IN K^0_{l3} DECAY. Lee, Chaunkuo. Philadelphia; Univ. of Pennsylvania (1970). 80p. University Microfilms Order No. 71-7827.

Thesis.

The branching ratio of $K^0_{\mu 3}$ to K^0_{l3} decays and the Dalitz plot distributions of these decays were measured in a spark chamber experiment in the 34° neutral beam of the Princeton–Pennsylvania Accelerator. From a sample of 3511 decays B.R. = 0.62 ± 0.04 is found. Also a coupling between λ_+, the energy dependence of the vector form factor, and a possible scalar form factor are observed. This coupling is such that if one sets $f_s/f_+ = 0$, then $\lambda_+ = 0.10 \pm 0.02$ and $\xi = -0.94 \pm .20$; while the imposition of the world average λ_+ of .02 ± 0.007 on the data gives $f_s/f_+ = 0.26 \pm 0.03$ and $\xi = -.40 \pm .43$. (Diss. Abstr. Int., B)

33531 DEPENDENCE OF KNOCK-ON ELECTRON CROSS SECTION ON MUON ENERGY IN HIGH, MEDIUM, AND LOW Z ELEMENTS. De, A. K. (Univ. of Calcutta); Das, A. K.; Bhattacharya, P. C.; Bhattacharyya, D. P.; Chaudhury Sen, P. K. Z. Phys.; 242: 304-7(1971).

Using the recent experimental results the dependence of the knock-on electron cross section on primary muon energy was studied in detail. It is found that the knock-on production cross section increases with primary muon energy up to at least 32 GeV in accordance with Bhabha's theory for energy transfers greater than 15 MeV. (auth)

Strong (Baryon-Induced)

Refer also to abstracts 33668 and 33971.

33532 (INP-713(Vol.2), pp 6-48) EXPERIMENTAL INFORMATION ABOUT MULTIPLE MESON PRODUCTION AT SUPER-HIGH ENERGIES. Gierula, J.; Wolter, W. (Institute of Nuclear Research, Krakow (Poland)).

A selection of methods and experimental facts for multiple meson production in cosmic ray jets is presented. Variables used in cosmic-ray jet research, observations in a world-wide sample of cosmic-ray jets, and observations in an unbiased sample of nucleon and pion interactions are discussed. (J.F.P.)

33533 (INP-713(Vol.2), pp 85-116) HYPERNUCLEI AND HYPERNUCLEAR SPECTROSCOPY. Pniewski, J. (Warsaw Univ. (Poland). Inst. of Experimental Physics. Institute of Nuclear Research, Warsaw (Poland)).

The review of hypernuclei and hypernuclear spectroscopy covers the identification of hypernuclei, binding energies, production, spin, lifetime, nonmesonic and π^+ decay, final-state interactions, the $\Lambda - N$ interaction, excited and resonance states, isomers, and gamma spectroscopy. (J.F.P.)

33534 (INR-P-1256) EMISSION OF DEUTERONS IN INTERACTIONS OF 9 GeV PROTONS WITH LEAD NUCLEI. Ciok, P. (Institute of Nuclear Research, Warsaw (Poland)). 1971. 13p. Dep. NTIS (U. S. Sales Only).

The emission of deuterons with energies ranging from 17 to 110 MeV in interactions of 9 GeV protons with lead nuclei was studied using nuclear emulsion. These deuterons constitute about 1/6 of the secondary heavily ionizing particles ($\beta < 0.7$). The results concerning the slower (E < 25 MeV) deuterons are consistent with the predictions of the evaporation model. Some observed features of the emission of the remaining deuteron part can be interpreted in terms of the mechanism proposed previously. (auth)

33535 (LA-4640) PLANNING FOR THE NUCLEON–NUCLEON PROBLEM AT LAMPF. Simmons, James E. (Los Alamos Scientific Lab., N. Mex.). Mar 1971. Contract W-7405-eng-36. 25p. Dep. NTIS.

The Los Alamos Meson Physics Facility has outstanding characteristics for the study of the nucleon-nucleon problem. A summary is given of the current status of LAMPF in relation to planning for future N-N work, including a description of the experimental area and special features of the neutron and proton beams. A summary will also be given of the present condition of the N-N problem at medium energies, including examples of knowledge of the phase shifts, and recent experimental results of interest. (auth)

33536 (NEVIS-185) OBSERVATION OF MUON PAIRS IN HIGH ENERGY HADRON COLLISIONS. Pope, Bernard G. (Columbia Univ., Irvington-on-Hudson, N. Y. Nevis Labs.). 1970. Contract AT(30-1)-1932. 145p. (CU-289; R-742). Dep. NTIS.

Thesis.

Muon pairs produced in the collisions of 30-GeV protons with a uranium target were observed in an experiment at the Brookhaven Alternating Gradient Synchrotron. The direction and range of each muon were measured and the effective mass of the pair calculated. The production cross section was seen to vary smoothly with mass as $(d\sigma/dm_{\mu\mu}) \approx 10^{-32}/m^5_{\mu\mu}$ cm²/GeV/c² for masses between 1 GeV/c² and 6.5 GeV/c². No evidence of resonant structure was found. Data were taken at incident proton energies of 22, 25, 28.5, and 29.5 GeV. Within the experimental aperture the total cross section increased with energy by a factor of 5 over this range. The experimental results are compared with the predictions of some theoretical models. (auth)

33537 POLARIZATION OF SECONDARY PROTONS IN REACTIONS $pp \rightarrow \pi^+pn$ AND $pp \rightarrow \pi^0pp$ AT 669 MeV. Azhgirei, L. S.; Vzorov, I. K.; Zhmyrov, V. N.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 581-7 (Mar 1971). (In Russian).

Polarization of secondary protons emitted with the energy ~370 MeV in reactions $pp \rightarrow \pi^+pn$ and $pp \rightarrow \pi^0pp$ is measured at angles of 8.3, 14.5, and 18.0° at the incident proton energy of 669 MeV. Along the direction of a normal to the plane containing the vectors of momenta of incident and registered protons, the polarization values are found to be: $P(8.3°) = 0.20 \pm 0.05$; $P(14.5°) = 0.21 \pm 0.05$, and $P(18.0°) = 0.15 \pm 0.05$. The results obtained can be described by the one-pion exchange model which takes into account the one-pion form factor of nucleons and the singularity of the amplitude behaviour of S_{11} state of πN system of the mass shell. (auth)

33538 LOW-VELOCITY MODERATION OF Σ^- HYPERONS IN HYDROGEN. Rubin, H. A.; Burnstein, R. A.; Misra, R. C. (Illinois Inst. of Tech., Chicago). Phys. Rev., A; 3: 1927-34 (1 Jun 1971).

A measurement of the low-velocity moderation of Σ^- hyperons in hydrogen was performed in a bubble-chamber experiment. The technique employed determines very accurately the Σ^- velocity at decay, $\Delta\beta = \pm 0.004$, by using $\Sigma^- \rightarrow \pi^- + n$ decays accompanied by neutron scatters with visible proton recoils. The results of the study, based on 23,200 Σ^- leading to 151 events with recoils in the region $\beta_{\Sigma^-} < 0.10$, indicate that the Σ^- moderation time for $\beta > 0.02$ agrees with the predictions of energy-loss theory using the first-order Born approximation and with experimental energy-loss data for protons. However, for the region $0.01 < \beta < 0.02$, the moderation-time data for Σ^-(and π^-) in hydrogen no longer agree with calculations based on the Born approximation or with experimental data for protons. The results for hydrogen are discussed and interpreted as being related to an "excess-range" effect previously observed for negative particles in emulsion. (auth)

33539 ANGULAR DISTRIBUTION OF SECONDARIES FROM PROTON–PROTON INTERACTIONS ABOVE 90 GeV. Lyon, D. E. Jr. (Univ. of Michigan, Ann Arbor); Bussian, A. E.; DeMeester, G. D.; (and others). Phys. Rev. Lett.; 26: 728-31(22 Mar 1971).

A cosmic-ray experiment at Echo Lake, Colorado, employing a liquid hydrogen target, spark chambers, and an ionization calorimeter was performed to study the interactions of protons with protons above 90 GeV. The results are reported on the angular distribution of the charged secondaries. (auth)

33540 SPIN AND PARITY OF THE D^0-MESON. Goldberg, M. (Institut de Physique Nucleaire, Paris); Makowski, B.; Touchard, A. M.; (and others). Lett. Nuovo Cim.; 1: No. 15, 627-31(10 Apr 1971).

XUM

The spin of the D^0 was studied in an analysis of $\bar{p}p \rightarrow K^0K^{\pm}\pi^{\pm}\pi^+\pi^-\pi^0$ interactions from bubble chamber events at 1.1 GeV/c. A spin assignment $J^{PC} = 1^{++}$ is found to be compatible with experiment. (L.B.S.)

33541 NEUTRON–PROTON CHARGE-EXCHANGE SCATTERING, 3 TO 12 GeV/c. Miller, E. L. (Ohio State Univ., Columbus); Elfield, Mark; Reay, N. W.; (and others). Phys. Rev. Lett.; 26: 984-7(19 Apr 1971).

A high-statistics measurement of the neutron–proton charge-exchange differential cross section for incident momenta 3 to 12 GeV/c, and four-momentum transfers 0.003 to 0.85 $(GeV/c)^2$, is reported. The data are normalized absolutely to ±20%. The differential cross section is characterized by a sharp peak at small momentum transfers, with a gentler exponential behavior at large momentum transfers. This shape is remarkably independent of the incident momentum. (auth)

33542 POSSIBILITY OF USING POLARIZED TARGET TO SEARCH FOR W BOSON IN NN COLLISIONS. Nurushev, S. B.; Folomeshkin, V. N. (Inst. of High Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 424-5(Feb 1971). (In Russian).

A possibility is considered of using a polarized proton target to select muons from W-boson decay in the background of electromagnetic and strong muons in experiments on the search for W boson in NN collisions. (auth)

33543 MEASUREMENT OF THE ABSORPTION AND STRIPPING CROSS SECTIONS FOR ANTIDEUTERONS AT THE MOMENTUM OF 13.3 GeV/c. Gorin, Yu. P.; Denisov, S. P.; Donskov, S. V.; (and others) (Inst. of High-Energy Physics, Serpukhov, USSR). Yadern. Fiz.; 13: 344-9(Feb 1971). (In Russian).

Cross sections are measured for absorption of antideuterons with the momentum of 13.3 GeV/c by Li, C, Al, Cu, and Pb nuclei. The antiproton stripping of the antideuterons is detected and the cross sections are measured for the C, Al, and Cu nuclei. From the stripping antiproton angular distribution the antideuteron binding energy is found to be $\epsilon_d^- = 2.4 \pm 0.6$ MeV. (auth)

33544 $\bar{p}p$ ANNIHILATION INTO $\pi^+\rho$ AT SMALL ANGLES BETWEEN 1 AND 2 GeV/c. Yoh, J. K. (California Inst. of Tech., Pasadena); Barish, B.; Nicholson, H. W.; (and others). Phys. Rev. Lett.; 26: 922-5(12 Apr 1971).

The process $\bar{p}p$ into π^+X^- was studied using wire spark chambers. The data cover the angular range of $\cos\theta^*_{\pi^+\rho^-}$ between 0.96 and 1.0 at several incident momenta between 1 and 2 GeV/c. The reaction $\bar{p}p \rightarrow \pi^+\rho^-$ was observed with $(d\sigma/d\Omega)^*$ of the order of 100 μb/sr at several momenta. (auth)

33545 ELASTIC SCATTERING OF TARGET PROTONS IN NUCLEON–NUCLEUS COLLISIONS. Imaeda, K.; Kazuno, M.; Fleming, P. (Dublin Inst. for Advanced Studies). Lett. Nuovo Cim.; 1: No. 14, 596-600(3 Apr 1971).

A sample of 67 nucleon-light nucleus interactions with $N_h \leq 7$ and primary energy between 50 and 10^4 GeV found in the Dublin part of the ICEF stack was analyzed to study the elastic p + p interactions producing knock-on protons and the interaction radius of the nucleon. The cross section for the elastic p + p interaction was estimated on the basis of two assumptions: that the interaction radius does not change with energy; and that the interaction radius increases with primary energy. (L.B.S.)

33546 CORRELATIONS BETWEEN LONGITUDINAL AND TRANSVERSE COMPONENTS OF PULSES OF SECONDARY PARTICLES IN pN-INTERACTIONS AT 21 GeV. Azimov, S. A.; Chernova, L. P.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk: No. 4, 80-3(1970). (In Russian).

Transverse and longitudinal $\langle p_\perp(p_{11})\rangle$ components for the secondary protons and pions of both sign charge in 729 pN-interactions were correlated with the number of the secondary charge particles n > 1, measured in nuclear emulsion irradiated by 20.8 GeV/sec protons in a strong (μ = 180 ke) magnetic field. Data obtained on the $\langle p_\perp(p_{11})\rangle$ distribution for various types of secondary particles of inelastic hadron interactions at accelerated energies showed that the distribution was only slightly dependent on the energy and the type of interaction and confirmed the kinematic nature of correlation between transverse and longitudinal components of pion moments. (R.V.J.)

33547 PROTON–PROTON TOTAL CROSS-SECTIONS BETWEEN 179 AND 555 MeV. Schwaller, P. (Swiss Inst. of Nuclear Research, Zurich); Pepin, M.; Measday, D. F.; (and others). Phys. Lett.; 35B: No. 3, 243-6(24 May 1971).

Proton-proton total cross sections were measured at nine different energies between 179 and 555 MeV (607 and 1162 MeV/c) with a typical accuracy of 0.9%. The accuracy is limited by a poor knowledge of the Coulomb-nuclear interference region in elastic scattering. (auth)

33548 ASYMMETRY IN THE SCATTERING OF PROTONS ON POLARIZED DEUTERONS AT 1.21 GeV/c. Albrow, M. G.; Borghini, M.; Bosnjakovic, B.; (and others) (CERN, Geneva). Phys. Lett.; 35B: No. 3, 247-51(24 May 1971).

By using a polarized deuteron target the asymmetry in the differential cross section was measured for elastic scattering of protons on deuterons and for quasi-elastic scattering of protons on protons bound in deuterons between the two states of opposite polarization, normal to the scattering plane of the initial deuteron. The beam momentum was 1.21 GeV/c. It is checked that the neutrons bound in the deuterons are polarized to approximately 20%. (auth)

33549 ANGULAR DISTRIBUTION OF SECONDARY PARTICLES IN pN-INTERACTIONS AT 21 GeV ENERGY. Azimov, S. A.; Svechnikova, L. N.; Chernova, L. P.; Chernov, G. M. (Inst. of Nuclear Physics, Tashkent). Dokl. Akad. Nauk Uzb. SSR; No. 8, 19-21(1970). (In Russian).

Data on angular distribution of secondary particles in the cms of pn interactions at $p_0 = 20.8$ GeV c were obtained using the experimental 729 interaction events selected from an effective 2.34 km long primary track in nuclear emulsion irradiated in a strong (H = 180 ke) magnetic field. Tables and diagrams show the magnitudes of the asymmetry coefficient $\alpha = (n_1 - n_2)/n$ (n_1 and n_2—of the number of particles with $\theta^* < \pi/2$ and $0^* > n/2$, n_1 to $n_2 = n$, respectively), and indicate the asymmetry "forward" for protons in pn-interactions. Results show that the mean recharge of nucleons is equal to 0.38 ± 0.02 for the inelastic pn interactions at $E_0 = 21$ GeV and identical in pp and pn events. (R.V.J.)

Strong (Meson-Induced)

Refer also to abstracts 33518, 33736, 33751, 33795, and 33956.

33550 (COO-1428-270) EVIDENCE FOR SPLITTING IN THE Q REGION OF $K^+\pi^+\pi^-$ MASS. Garfinkel, A. F.; Holland, R. F.; Carmony, D. D.; Clopp, H. W.; Cords, D.; Loeffler, F. J.; Rangan, L. K. (Purdue Univ., Lafayette, Ind.); Lander, R. L.; Pellett, D. E.; Yager, P. M. (California Univ., Davis). [1970]. 10p. Dep. NTIS.

A splitting in the $K^+\pi^+\pi^-$ mass spectrum in K^+d interactions at 9 GeV/c is observed. A mass of 1243 ± 8 MeV/c^2 and a width of $70 \pm^{26}_{18}$ for the lower mass state, and a mass of 1344 ± 4 and a width of less than 40 MeV/c^2 for the higher mass state are found. The isospin of both states is determined to be ½. The results can be interpreted as evidence for the mixing of two $J^P = 1^+$ K^* states. (auth)

33551 (LAL–1244) COHERENT PRODUCTION ON THE NUCLEUS OF SYSTEMS WITH TWO, THREE, FOUR, AND FIVE MESONS BY K^- OF 5.5, 10, AND 12.7 GeV/c. Daugeras, B. ([Paris Univ., Orsay (France). Laboratoire de l'Accelerateur Lineaire]). Feb 1971. 171p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Reactions of K^- at 5.5 to 12.7 GeV/c with heavy nuclei in a bubble chamber are studied for the coherent production of several meson states. In particular of states decaying into π^0 are studied. The principal results obtained in the channels analyzed are the coherent production of K(890) and Q. The K(890) is found to decay into $K^-\pi^0$ and $K^0\pi^-$, and Q decays into $K^*\pi$, Kρ, and Kω. Cross sections for the decay of Q into $K^-\pi^+\pi^-$, $K^0\pi^-\pi^0$, and $K^-\pi^0\pi^0$ are also given. (J.F.P.)

33552 (NP–18830) MEASUREMENT OF THE POLARIZATION PARAMETER IN HIGH-ENERGY K–p ELASTIC SCATTERING. Cronenberger, Denise (Paris Univ., Orsay (France). Faculte des Sciences). 1970. 44p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The polarization parameters in K^+p and K^-p elastic scattering were measured for energies between 6 and 18 GeV. The experiments were made using the secondary P_4 beam of the CERN proton synchrotron. Two targets were used, an LMN crystal (lanthanum magnesium double nitrate), and a frozen solution of a butyl alcohol in deoxygenated water, the polarization of the free protons of the targets being produced by a dynamic spin orientation process. The polarization behavior was studied and a test was made of the Regge models for KN scattering, inside their validity range (below 6 GeV/c). A comparison of the results and of the

theoretical predictions led to a critical examination of the models. The Blackmon and Goldstein, and the Dass, Michael, and Phillips models give the best agreement with these results and with previous ones concerning the lower energy intermediate region. The agreement is not so good for the polarization in K−p scattering with low transfer momentum. (France)

33553 (NP-18840) STUDY OF HIGH ENERGY πN BACKWARD SCATTERING: MEASUREMENT OF THE $\pi^-p \to n\pi^0$ DIFFERENTIAL CROSS SECTION AND BARYON EXCHANGE MODEL WITH ABSORPTION. Schneider, Jean (Paris Univ. (France). Faculte des Sciences). 1971. 62p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Backward πN scattering reactions were studied from a measurement of the differential cross section of the charge exchange reaction $\pi^-p \to \pi^0n$. The originality of the experimental method concerns the photograph analysis: a relation was established between the energy of the gamma photon emitted and the number of sparks produced in the spark chamber; this measurement led to an improvement in the resolution. The contamination due to unwanted π^0 was estimated at 4 GeV/c, 6 GeV/c, 8 GeV/c, and 11 GeV/c. The results obtained were reinserted into the backward πN scattering model using a kinematic reconstitution and a Monte-Carlo simulation. A Regge pole model with absorption is used, in which the three Nα, Nγ, and Δ trajectories intervene. The absorption phenomena which occur, explain why the differential cross section of the $\pi^-p \to p\pi^-$ reaction does not present a minimum for the cancellation of the Δ trajectory signature (−1, 8 GeV/c^2 transfer). A maximum polarization is predicted at −7 GeV/c^2. The contribution from the Nγ isospin exchange trajectory makes any quantitative prediction of the π^+p polarization difficult. (France)

33554 (UCRL-20622) A2 DUPLICITY: A COMPILATION OF THE AMOUNT OF DIPOLE STRUCTURE OBSERVED IN A2 MESON EXPERIMENTS. Lynch, Gerald R. (California Univ., Berkeley. Lawrence Radiation Lab.). 10 Mar 1971. Contract W-7405-eng-48. 3p. Dep. NTIS.

In order to compare experiments for splitting in the A_2 meson, these experiments are fit to a distribution containing a parameter, called duplicity, with measures the amount of dipole structure observed in an experiment. The experiments are listed showing the resolution, duplicity, and S values. (J.F.P.)

33555 (UCRL-20628) A STUDY OF K^+p AND K^+d INTERACTIONS AT 1.585 GeV/c. Seeger, Victor Harrison (California Univ., Berkeley. Lawrence Radiation Lab.). 4 Jan 1971. Contract W-7405-eng-48. 112p. Dep. NTIS.

Thesis.

The Lawrence Radiation Laboratory's 25-inch bubble chamber filled first with hydrogen and then with deuterium was exposed to incident K^+'s at 860, 970, 1210, 1365, and 1585 MeV/c. The analysis of the data taken at 1585 MeV/c is covered. Single and double pion production reactions and the charge exchange reaction were studied. Single pion and double pion production cross sections were obtained. Relations derived from isospin conservation were used to obtain some cross sections not accessible to direct observation. Single pion production is dominated by KΔ and K*N production. K*-Δ interference was observed and measured by fitting the Dalitz plots. K*-background and Δ-background interference also was observed. Double pion production reactions were seen to be dominated by KΔ production even below the nominal K*Δ threshold. The cross section for K* production in the I = 0 channel in single pion production was obtained and its production and decay angular distributions were studied in terms of t channel analysis. Its production was seen to proceed almost entirely via pseudoscalar exchange. This is in contrast with K* production in the I = 1 channel which proceeds largely through vector exchange but the behavior of the cross section as a function of beam momentum is very similar to that of the K* in the I = 1 channel. A rough model involving π, ρ, and ω exchange is seen to account for the general features of K^{*0} and K^{*+} production. More detailed features were seen, in particular correlations between decay angles, which are not accounted for by OME models. The differential cross section for the charge exchange reaction was measured and compared with predictions of a model based on Regge theory. The absolute value of the ratio of the real part of the scattering amplitude in the forward direction to the imaginary part was measured and found to be in good agreement with another Regge theory prediction. (auth)

33556 GENERATION OF STRANGE PARTICLES ON NUCLEI BY 3.9-GeV/c π^- MESONS. Bederkin, A. T.; Mikhailichenko, V. I.; Ponosov, A. K.; (and others) (Moscow Engineering Physical Inst.). Yadern. Fiz.; 13: 576-80(Mar 1971). (In Russian).

Momentum and angular distributions of K^0 mesons and Λ hyperons are given which are generated in the interactions of 3.86-GeV/c π^- mesons with the nuclei of freon mixture ($C_2F_3Cl_3$). The comparison with the statistical theory of multiple production indicates the necessity to account for the peripheral collisions. (auth)

33557 MEASUREMENT OF T = 2 ELASTIC ππ CROSS SECTIONS. Colton, E. (Univ. of California Berkeley); Malamud, E.; Schlein, P. E.; (and others). Phys. Rev., D; 3: 2028-33(1 May 1971).

Experimental differential cross sections from data on the reaction $\pi^-p \to (\pi^-\pi^-)\Delta^{++}$ at beam momenta of 2.7, 3.0, 3.2, 3.9, and 4.2 GeV/c were extrapolated to the one-pion-exchange pole to obtain the $\pi^-\pi^-$ elastic scattering cross section. An attempt is made to correct for background due to kinematic overlap with the competing one-pion-exchange process $\pi^-p \to \rho^0(\pi^-p)$. Analyses done independently on the data in two beam-momentum groupings at ~3.0 and ~4.0 GeV/c give consistent results of a roughly constant 7 to 11-mb cross section for $\pi^-\pi^- \to \pi^-\pi^-$ over the dipion mass range 440 to 750 MeV. The results are compared with available results from other analyses and with several theoretical predictions for the T = 2 s-wave phase shift δ_0^2. (auth)

33558 POLE EXTRAPOLATION OF THE REACTIONS $\pi^-p \to \pi^-\pi^+n$ AND $\pi^+p \to \pi^+\pi^-\Delta^{++}(1238)$. Colton, Eugene (Univ. of California, Berkeley); Malamud, Ernest. Phys. Rev., D; 3: 2033-42(1 May 1971).

Experimental differential cross sections from data on the reactions $\pi^-p \to \pi^-\pi^+n$ and $\pi^+p \to \pi^+\pi^-\Delta^{++}(1238)$ were extrapolated to the one-pion-exchange pole to obtain the $\pi^+\pi^-$ elastic scattering cross section from threshold to 1.4 GeV. Consistent results are obtained in three c.m. energy ranges for both reactions. The data were fitted to several t-dependent extrapolation functions, and the results of the fits are tabulated and plotted as a function of $\pi^+\pi^-$ effective mass. In particular, cross sections of approximately 25 and 125 mb, respectively, at the K and central $\rho^0(765)$ mass positions are found. (auth)

33559 EVIDENCE FOR THE INTERNAL STRUCTURE OF HADRONS OBTAINED FROM MULTIPION PRODUCTION. Elbert, J. W.; Erwin, A. R.; Walker, W. D. (Univ. of Wisconsin, Madison). Contracts AT(11-1)-881; COO-881-289. Phys. Rev., D; 3: 2042-7(1 May 1971).

The striking asymmetry observed in the longitudinal momentum distribution of produced pions essentially disappears when production is viewed in a coordinate system where the incident proton has a momentum equal to ½ that of the incident pion. Interpretation of this result in the framework of a quark model appears to suggest some simple production rules as well as several new experiments. (auth)

33560 STUDY OF THE TWO-CHARGED-PARTICLE FINAL STATES OF 3.9-GeV/c π^+p INTERACTIONS INCLUDING A LONGITUDINAL-MOMENTUM ANALYSIS OF THE ONE-PION-PRODUCTION CHANNELS. Bastien, P. L.; Carmel, Z.; Dao, F. T.; (and others) (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 3: 2047-64(1 May 1971).

The two-prong final states in π^+p interactions at 3.9 GeV/c were analyzed. The result for elastic scattering is σ(elastic) = 6.50 ± 0.1 mb (statistical error only). The elastic slope is found to be 6.61 ± 0.14 $(GeV/c)^{-2}$. The elastic forward cross section is found to be 40.0 ± 1.4 mb/$(GeV/c)^2$. A longitudinal-momentum analysis was applied to the one-pion-production channel. The cross section for the reaction $\pi^+ + p \to \pi^+ + \pi^0 + p$ was found to be 2.30 ± 0.06 mb and that for $\pi^+ + p \to \pi^+ + \pi^+ + n$ to be 1.45 ± 0.05 mb. For resonance-production cross sections in these channels Δ(1236) = 0.60 ± 0.07 mb, ρ(760) = 0.86 ± 0.06 mb, and diffraction dissociation = 1.69 ± 0.11 mb were obtained. It is found that all distributions can be satisfactorily fit in the one-pion-production channel without assuming any phase-space production. In the missing-mass channel dominant $\Delta^{++}(1236)$ production plus evidence for A_2^+ production were observed. (auth)

33561 ASYMMETRY MEASUREMENTS FOR ELASTIC SCATTERING OF K^+ MESONS BY POLARIZED PROTONS. Ehrlich, R. D.; Etkin, A.; Glodis, P.; (and others) (Yale Univ., New Haven). Phys. Rev. Lett.; 26: 925-8(12 Apr 1971).

Measured values of the asymmetry in the elastic scattering of K^+ mesons from polarized protons are reported. The data were obtained at fourteen incident K^+ momenta from 1.33 to 2.58 GeV/c; the approximate angular range covered was $-0.85 < \cos\theta_K^{c.m.} < 0.9$. The results are compared with other available measurements and several significant differences are noted. (auth)

33562 TOTAL CROSS SECTIONS FOR $\pi^-p \to \Lambda K^0$ FROM THRESHOLD TO 1.13 GeV/c. Jones, J. J.; Bowen, T.; Dawes,

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W. R.; (and others) (Univ. of Arizona, Tucson). Phys. Rev. Lett.; 26: 860-3(5 Apr 1971).

Total cross sections for $\pi^- p \rightarrow \Lambda K^0$ were measured using optical spark chambers from threshold to 1.13-GeV/c beam momentum in 19-MeV/c intervals, but with a 1-MeV/c resolution in the regions of the ΛK and ΣK thresholds. The behavior near ΛK threshold indicates a significant s-wave contribution, but this experiment is unable to resolve any cusplike behavior in the region of the ΣK thresholds. The cross section shows a broad peak in the vicinity of 1.05-GeV/c beam momentum. (auth)

33563 FAILURE OF s-CHANNEL HELICITY CONSERVATION IN A_1^- PRODUCTION. Ascoli, G. (Univ. of Illinois, Urbana); Brockway, D. V.; Eisenstein, L.; (and others). Phys. Rev. Lett.; 26: 929-32(12 Apr 1971).

A study of the A_1^- density-matrix elements shows that s-channel helicity is not conserved in the process $\pi^- p \rightarrow A_1^- p$ between 5 and 25 GeV/c. Instead the A_1^- density-matrix elements have simple behavior in the t-channel helicity frame. A new analysis of the A_1^- cross section as a function of the incident π^- momentum is also presented. (auth)

33564 REACTION $K_L^0 p \rightarrow K_S^0 p$ FROM 1.3 TO 8.0 GeV/c. Brody, A. D.; Johnson, W. B.; Kehoe, B.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: 1050-3(26 Apr 1971).

Total and differential cross sections are presented for the reaction $K_L^0 p \rightarrow K_S^0 p$ from 1.3 to 8.0 GeV/c as measured in an exposure of the Stanford Linear Accelerator Center 40-in. hydrogen bubble chamber to a neutral beam. The forward points of $d\sigma(K_L^0 p \rightarrow K_S^0 p)/dt$ together with $K^+ n$ and $K^- n$ total cross sections are used to determine the intercept of the effective Regge trajectory, $\alpha(0) = 0.47 \pm 0.09$, and the regeneration phase $\varphi_f = -43° \pm 8°$. (auth)

33565 SCALING AND FACTORIZATION IN $K^+ + p \rightarrow \pi^- +$ ANYTHING. Ko, Winston; Lander, Richard L. (Univ. of California, Davis). Contract AT(04-3)-34PA191. Phys. Rev. Lett.; 26: 1064-7(26 Apr 1971).

The π^- momentum distributions from the reaction $K^+ + p \rightarrow \pi^- +$ anything at 11.8 GeV/c are reported. The shape of the distribution in longitudinal momentum of the π^- is compared with that of π^- mesons produced in the reaction $\pi^- + p \rightarrow \pi^- +$ anything at 25 GeV/c and $\pi^+ + p \rightarrow \pi^- +$ anything at 18.5 GeV/c in terms of the scaling variable $x = 2p_L/\sqrt{s}$. The backward distributions are found to be independent of the nature of the projectile. The forward distributions are different in shape from the backward, but are remarkably similar for $K^+ p$ and $\pi^+ p$ interactions. The distribution in longitudinal momentum in the center-of-mass system is not independent of the value of the transverse momentum. (auth)

33566 RESONANCE PRODUCTION IN $\pi^+ d$ REACTIONS AT 5.4 GeV/c. Farber, M. S.; Farber, M. S.; DePinto, J. V.; Biswas, N. N.; (and others) (Univ. of Notre Dame, Ind.). Nucl. Phys.; B29: 237-58(1971).

The reactions $\pi^+ n \rightarrow p\pi^+\pi^-$, $\pi^+ n \rightarrow p\pi^+\pi^-\pi^0$ and $\pi^+ n \rightarrow pK^+K^-$ were studied at 5.4 GeV/c. Cross sections (normalized to the reaction $\pi^- p \rightarrow n\pi^+\pi^-$) are estimated as 1.60 ± 0.25 mb, 1.43 ± 0.24 mb and 0.14 ± 0.03 mb, respectively. Resonance parameters, production cross sections, and density-matrix elements are presented for the ρ^0 and f^0 produced in the $p\pi^+\pi^-$ final state; cross sections are given for ρ, $\Delta(1236)$, ω^0, η^0 and A_2^0 resonances produced in the $p\pi^+\pi^-\pi^0$ final state. Density-matrix elements are presented for the ω^0 and the variation of these elements as a function of beam momentum is discussed. Evidence is presented for a low-mass enhancement in the $p\pi^-\pi^0$ system produced diffractively in the reaction $\pi^+ n \rightarrow (p\pi\pi)^0\pi^+$. No indication of ϕ^0 (1020) or S^* (1070) production is seen in the K^+K^- system. (auth)

33567 STUDY OF THE REACTION $K^- n \rightarrow K^-\pi^- p$ AT 12.6 GeV/c. Antich, P.; Callahan, A.; Carson, R.; (and others) (Johns Hopkins Univ., Baltimore). Nucl. Phys.; B29: 305-16 (1971).

From a 2.5 events/μb $K^- d$ exposure of the BNL 80″ bubble chamber 351 events were obtained which successfully fit the reaction $K^- d \rightarrow K^-\pi^- pp_s$. The $(p\pi^-)$ mass spectrum exhibits a strong enhancement, centered at 1400 MeV and 400 MeV wide, which cannot be clearly resolved into individual resonances. The reaction is analyzed with a diffraction dissociation model and the relevant cross sections are given. From a study of the low $K^-\pi^-$ mass region it is found that the $K\pi$ elastic scattering cross section in the isospin $\frac{3}{2}$ state is of the order of 2 mb. (auth)

33568 STUDY OF THE REACTION $\pi^- p \rightarrow \rho^0 n$ AT 15 GeV/c. Bulos, F. (Stanford Univ., Calif.); Carnegie, R. K.; Fischer, G. E.; (and others). Phys. Rev. Lett.; 26: No. 23, 1453-6(7 Jun 1971).

We present the results of a wire spark-chamber experiment studying the reaction $\pi^- p \rightarrow \pi^+\pi^- n$ at 15 GeV/c. The differential cross section, π-π mass distribution, and density-matrix elements were determined from 10,000 $\pi\pi n$ events ($M_{\pi\pi} < 1.0$ GeV) produced with $-t < 0.30$ (GeV/c)^2. Both the density-matrix elements and the differential cross section exhibit structure in the forward direction ($-t < m_\pi^2$). (auth)

33569 COMPARISON OF $\pi^- p \rightarrow \rho^0 n$ WITH SINGLE-PION PHOTOPRODUCTION AT 15 GeV/c. Bulos, F.; Carnegie, R. K.; Fischer, G. E.; (and others). (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: No. 23, 1457-60(7 Jun 1971).

A comparison of new data on $\pi^- p \rightarrow \rho^0 n$ at 15 GeV/c with polarized and unpolarized single-pion photoproduction data is presented. Particular emphasis is placed upon the behavior of the differential cross sections and asymmetries in the forward direction ($-t < m_\pi^2$). Qualitative agreement with the vector-dominance model is found. Quantitative agreement is found for the unnatural-parity–exchange cross section and for the asymmetry at low momentum transfer. Elsewhere there are disagreements in detail which may not be explained by changes of normalization. (auth)

33570 EVIDENCE FOR AN ADDITIONAL RESONANCE IN THE REGION OF THE K*(1420). Firestone, A.; Goldhaber, G.; Lissauer, D. (Univ. of California, Berkeley). Phys. Rev. Lett.; 26: No. 23, 1460-3(7 Jun 1971).

An additional K* resonance was observed on the low-mass side of the K*(1420) in the reaction $K^+ n \rightarrow K^+\pi^- p$ at 12 GeV/c. This resonance has parameters $M \approx 1370$ MeV and $\Gamma < 150$ MeV, and is probably produced by a pion-exchange mechanism with $J^P = 0^+$; but the alternative hypotheses of a $J^P = 1^-$ or a $J^P = 2^+$ resonance cannot be ruled out at this time. (auth)

33571 NEW EVIDENCE FOR THE $P_{11}(1470)$ RESONANCE IN $\pi^- + p \rightarrow n + \pi^0$ BELOW 600 MeV. Hauser, M. G.; Chen, K. W.; Crean, P. A. (Princeton Univ., N. J.). Contract AT(30-1)-4159. Phys. Lett.; 35B: No. 3, 252-6(24 May 1971).

The differential cross section for $\pi^- p \rightarrow n\pi^0$ was measured in detail from 150 to 600 MeV. The backward cross section has a previously unobserved dramatic dip at 425 MeV. This dip is interpreted in terms of interference between the $P_{33}(1236)$ and the $P_{11}(1470)$ resonances. These data provide strong evidence for the adequacy of the phase shift solutions in this energy range. (auth)

33572 TEST OF CHARGE INDEPENDENCE IN π p BACKWARD SCATTERING BELOW 600 MeV. Chen, K. W. (Michigan State Univ., East Lansing. Princeton Univ., N. J.); Hauser, M. G. Contract AT(30-1)-4159. Phys. Lett.; 35B: No. 3, 257-60(24 May 1971).

Charge independence in the strong interactions was tested by examining the backward cross sections for pion-nucleon scattering from 150 to 600 MeV. In contrast to the conclusion suggested by previous data, present data reveal no compelling evidence for a violation. At 425 MeV, an upper limit (90% confidence) of 0.3 is found for the ratio of the magnitude of the isospin violating amplitude to the magnitude of the π^+ elastic scattering amplitude. (auth)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstract 33822.

33573 (DESY–71/13) HIGH ENERGY SCATTERING IN ϕ THEORY AND THE BREAKDOWN OF EIKONAL APPROXIMATION. [PART] I. Cheng, Hung; Wu, Tai Tsun (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar 1971. Contract AT(30-1)-4101. 55p. Dep. NTIS.

In order to test the general validity of the impact picture which was extracted from quantum electrodynamics at high energies, a systematic study of high energy scattering amplitudes in ϕ^3-theory is made. The method used is the one developed in the treatment of quantum electrodynamics, and it enables one to obtain in closed forms the asymptotic amplitudes for multiple exchanges of Regge poles and scalar particles. The result is nonperturbative and is valid to all orders of the coupling constant. It is shown in various examples that: the longitudinal momentum of the incident particle is always distributed in positive fractions by the particles created; an exchange particle, either composite (Regge pole) or elementary, can carry only transverse momentum; the scattering amplitude satisfies the impact factor representation; except in the leading order of the coupling constant, the simple exponentiation form of the eikonal

approximation does not appear. The eikonal approximation fails in ϕ^3-theory because of particle creation: more than one particle may share the incident longitudinal momentum, and it is impossible to single out a particular particle to be associated with the eikonal path. The above conclusions are reached by a study of the one-ladder amplitude and the amplitude for the double exchange of a ladder and a scalar particle. (auth)

33574 (INP-713(Vol.2), pp 117-21) NON-POLYNOMIAL LAGRANGIANS AND THE PARTON MODEL OF HIGH ENERGY COLI ISIONS. Rayski, Jerzy (Jagellonian Univ., Krakow (Poland). Inst. of Physics).

It is shown that the parton model for high-energy interactions follows naturally from a consistent quantum field theory. (J.F.P.)

33575 (JINR-P2-5661) THREE-DIMENSIONAL RELATIVISTIC EQUATION IN APPLICATION TO THE PARTICULAR PROBLEMS OF THE THREE-BODY THEORY. Vinogradov, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

On the basis of the relativistic Faddeev equations obtained in the framework of the three-dimensional formulation of quantum field theory, the following questions are considered. These are as follows: a) separable approximation in the two- and three-body problem, b) partial analysis of the three-body equations, c) high-energy scattering on the complex weakbound system. Some arguments in favor of replacing the nonrelativistic equations by the relativistic ones, which lead to increasing of the energy of the bound states, are given. It is shown that the well-known Glauber's formula for problem c) can be obtained under stronger assumption about behavior of the two-particle amplitude at high energies. (auth)

33576 (NP-18756) KINEMATICS OF MULTIPARTICLE FINAL STATES IN HIGH-ENERGY REACTIONS. Nyborg, Per (Agricultural Coll. of Norway, Vollebekk. Dept. of Mathematics). Nov 1969. 127p. Dep. NTIS (U. S. Sales Only).

Multiparticle final states are described in terms of invariant masses, invariant momentum transfers, and angles. The major part is concerned with description of n-particle phase space in terms of 2n-3 invariant variables and n-1 azimuthal angles. For n = 3, 4, and 5, explicit expressions for a large number of phase space projections are established. The emphasis is on explicit expressions and alternative descriptions that may be useful for experimentalists. The various complete descriptions of phase space in terms of 3n-4 independent variables are suitable for Monte Carlo calculations. The partially integrated forms may be used to simplify the evaluation of normalization integrals in a maximum likelihood analysis. The various descriptions involve different reference frames. The general formulas for the laboratory frame description also appear in a previous description of phase space. (auth)

33577 MULTIPLE HADRON GENERATION AND THE STATISTICAL THEORY. Feinberg, E. L. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: 659-69(Mar 1971). (In Russian).

Both the experiment and the theory indicate that at considerable multiplicity ($n_s \gtrsim 5$) the particles are generated in groups (clusters, fireballs) within which the four-momentum transfers are large. It is reasonable to apply the statistical theory to such groups. Revision of the foundation of the theory and application to the high energy processes show that the theory is well founded, helpful and in agreement with experiment if one uses not the original Fermi theory but its modification by Pomeranchuk, that is free from its inconsistencies; the object to apply the theory is carefully selected and satisfies the conditions of the theory; often not the total system of the colliding particles and the products is the object but a subsystem produced as a result of a peripheral collision. After the only numerical parameter of the theory (the decay temperature of the statistical system, its order of magnitude is known a priori) is determined from comparison with the experiment, it is found that the total set of experimental facts is well described for such objects: composition of the generated particles (including $\bar{d}$ and $\overline{He_3}$), multiplicity, transversal momentum distribution, its dependence on n_s and on the particle masses. (auth)

33578 ALMOST-INFINITE-MOMENTUM FRAME, LIGHT-CONE COMMUTATORS, AND SCALING LAWS. Chen, Tuan Wu (New Mexico State Univ., Las Cruces). Phys. Rev., D; 3: 1989-91(15 Apr 1971).

The high-momentum behavior of the structure functions $W_i(\kappa,\nu)$ is considered in the almost-infinite frame which is obtained by rotating the usual frame (x,y,z,t) by almost $\frac{1}{4}\pi$ degrees in the z-t plane. In particular, it is shown that the major contributions to $W_i(\kappa,\nu)$ come from the current commutators near the light cone in the Bjorken limit as well as in the Regge limit, not necessarily in the deep Regge limit as is usually concluded. Implications of this conclusion are then given. (auth)

33579 THEORETICAL ANGULAR DISTRIBUTIONS AND POLARIZATIONS IN THE THREE-BODY PROBLEM. Fayard, C.; Lamot, G. H.; El Baz, E.; (and others) (Faculte des Sciences, Lyon). Nuovo Cim.; 3A: 158-78(1 May 1971).

General expressions for angular distribution and polarization in the three-body problem are given in the Faddeev and Faddeev-Lovelace formalisms. In the last case it is shown how the general results simplify for the (n,d) scattering. (auth)

33580 ALMOST-INFINITE-MOMENTUM FRAME AND HIGH-ENERGY SCATTERING PROCESSES. Chen, T. W. (New Mexico State Univ., Las Cruces). Phys. Rev., D; 3: 2257-61(1 May 1971).

A useful frame for studying high-energy scattering is introduced. It is a rotation of the usual space-time coordinate in the zt plane by the angle $\frac{1}{4}\pi - \frac{1}{2}\gamma$ in the limit $\gamma \to 0$. The structure functions $W(\kappa,\nu)$ for scattering processes in the limits of infinite momenta are considered in this special frame. By linking the limiting process $\gamma \to 0$ with that of infinite momentum, it is shown that $W(\kappa,\nu)$ is scaled if $\nu \to \infty$ and $\kappa \neq 0$ (not necessarily large). Moreover, the region of validity for the scaling law is established and is found to be consistent with experiments. (auth)

33581 THEORETICAL AND EXPERIMENTAL CONSEQUENCES OF A VIOLATION OF THE POMERANCHUK THEOREM ON TOTAL CROSS SECTIONS AT HIGH ENERGIES. Eden, R. J.; Kaiser, G. D. (Cavendish Lab., Cambridge, Eng.). Phys. Rev., D; 3: 2286-8(1 May 1971).

Bounds are obtained on near-forward scattering amplitudes that violate the Pomeranchuk theorem. It is proved that these amplitudes have zeros in $C' < |t| \ln^2 s < C''$. Experimental consequences are estimated, including phases of near-forward amplitudes, growth of the forward peak and shrinkage of its width, and possible oscillations. A narrow peak in the Coulomb region cannot be excluded and may invalidate experimental estimates of total cross sections. (auth)

33582 PROPERTIES OF THE AMPLITUDES WITH LOGARITHMICALLY INCREASING INTERACTION RADIUS. Gribov, V. N.; Kobzarev, I. Yu.; Mur, V. D.; Okun, L. B.; Popov, V. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 670-80(Mar 1971). (In Russian).

On the basis of dispersion relations in s at fixed q and unitarity condition, it is shown that independently of whether or not the Pomeranchuk condition is satisfied ($\sigma = \bar{\sigma}$), the integral $J(q) = \int_0^\infty [\mathrm{Im}F(\xi,q) - \mathrm{Im}\bar{F}(\xi,q)]d\xi$ where $\xi = \ln s$, converges at $q^2 > 0$. If the total cross sections for particle and antiparticle are constant and do not equal to each other ($\sigma,\bar{\sigma} \approx$ const; $\sigma \neq \bar{\sigma}$) then $qJ(q) \to 0$ at $q \to 0$. To satisfy this condition it is necessary for the difference $\mathrm{Im}F(\xi,q) - \mathrm{Im}\bar{F}(\xi,q)$ to be sign-alternating function of ξ and q. (auth)

33583 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 9, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 67p.

33584 HIGH ENERGY PHYSICS INDEX. VOLUME 9, NO. 8, 1971. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1971). 78p.

33585 CONSEQUENCE OF ANALYTICITY OF FORM FACTOR. Nguyen Thi Hong (Inst. of Physics, Democratic Republic of Vietnam). Yadern. Fiz.; 13: 409-10(Feb 1971). (In Russian).

It is shown that as a result of analyticity of the form factor F(t) in the t plane with the cut at $t \geq 4m_\pi^2$ the inequality is valid: $|F'(0)| \leq (1/16m_\pi^2)(M^2 - 1/M)$ where M is the maximum value of the modulus of F(t) on the cut. No assumptions on zeros of F(t) are done. (auth)

33586 HIGH-ENERGY PARTICLE PRODUCTION AND REGGE CUTS IN ELASTIC NN, πN, AND KN SCATTERING. Kaidalov, A. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 401-8(Feb 1971). (In Russian).

Experimental data on high-energy particle production are used to determine the vacuum pole contribution to the cross section of inelastic processes σ^P. It is shown that the processes due to the vacuum pole comprise a small fraction (~10%) of the total inelastic cross section. The obtained information on σ^P allows one to determine the value of the two-reggeon PP cut in elastic scattering processes. The deviations from the eikonal model are 0.35 in NN scattering and 0.6-0.7 in πN and KN scattering. (auth)

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33587 RANDOM EVENT GENERATION WITH PREFERRED FREQUENCY DISTRIBUTIONS. Friedman, Jerome H. (Univ. of California, Berkeley). J. Comput. Phys.; 7: 201-18(Apr 1971).

A method of random event generation is described that allows wide choices for the frequency distribution of the generated events in Lorentz-invariant phase space. (auth)

33588 OCTONIONS AND ISOSPIN. Penney, R. (Ford Motor Co., Dearborn, Mich.). Nuovo Cim.; 3B: No. 1, 95-113(11 May 1971).

The Cayley algebra or algebra of octonions is used to extract the square root of the classical Hamiltonian, in place of the Dirac–Clifford algebra. The resulting wave equation is linear and covariant and possesses a positive definite conserved probability density, and a Lagrangian. The wave function is an octonion, and may be represented as a pair of quaternions. The wave function then possesses an internal degree of freedom which corresponds to multiplication from the right by the Pauli matrices. Lorentz transformation of the wave function is effected by left multiplication, which does not mix up isospin eigenstates. The wave equation seems appropriate for a dynamical description of an isospin doublet. The electromagnetic properties of the objects described by the wave function are those of a Dirac particle with the usual magnetic moment. (auth)

33589 INTRODUCTION TO ELEMENTARY PARTICLES. SECOND EDITION. Williams, W. S. C. Pure and Applied Physics. Volume 12. A Series of Monographs and Textbooks. New York; Academic Press, Inc. (1971). 542p. $18.50.

The methods available for explaining and understanding the behavior of elementary particles are described; emphasis is given to the effects of symmetry and invariance laws. Topics discussed include: quantum mechanics; angular momentum; scattering and reaction theory; energy dependence in scattering; symmetry, isotopic spin, and hypercharge; parity, time reversal; charge conjugation, and G-parity; bosons; baryons; unitarity symmetry; field theory; weak interactions; strong interactions; electromagnetic interactions of hadrons; and the neutral kaons and CP conservation. (L.B.S.)

33590 CURRENT–STRESS TENSOR COMMUTATORS. Deser, Stanley (Brandeis Univ., Waltham, Mass.); Morrison, L. Kent. J. Math. Phys. (N. Y.); 12: No. 4, 631-3(Apr 1971).

The model-independent components of current-stress tensor equal-time commutators are derived for arbitrary spin 0 and 1 systems. (auth)

33591 DUAL THEORY FOR FREE FERMIONS. Ramond, P. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 3: No. 10, 2415-18(15 May 1971).

A wave equation for free fermions is proposed based on the structure of the dual theory for bosons. Its formal properties preserve the role played by the Virasoro algebra. Additional Ward-like identities, compatible with the equation, are shown to exist. Its solutions lie on linear trajectories. In particular, the parent is shown to be doubly degenerate, but these solutions lie on different sheets of the cut j plane. (auth)

33592 ELEMENTARY PARTICLE THEORY. Martin, A. D.; Spearman, T. D. New York; American Elsevier Publishing Company, Inc. (1970). 537p. $27.50.

The book contains the basic formalism that underlies much of the current theoretical work in elementary particles. Emphasis is given to the strong interactions and a substantial part of the book deals with the analytic properties of scattering amplitudes and the application of these properties to problems in strong interactions. Problems are included for each chapter. (L.B.S.)

Electromagnetic

Refer also to abstracts 33516, 33569, 33804, and 33837.

33593 (DESY-71/15) INELASTIC ELECTRON-PHOTON SCATTERING. Walsh, T. F. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar 1971. 12p. Dep. NTIS (U. S. Sales Only).

It is suggested that colliding e^+e^- beam machines may be used to study inelastic electron-photon scattering. (auth)

33594 (JINR-E2-5748) W PRODUCTION IN NUCLEON–NUCLEON COLLISIONS. Kunszt, Z. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 9 Apr 1971. 16p. Dep. NTIS (U. S. Sales Only).

The cross section for the production of the intermediate vector boson in high-energy nucleon–nucleon collisions is estimated in some of the models proposed for the description of the highly inelastic processes. An expression for the total cross section is obtained, which is a smooth function of the c.m. energy and the mass of the W-boson. (auth)

33595 (JINR-P4-5690) TABLES OF INTENSITY OF TRANSITION RADIATION FOR NON-RELATIVISTIC PARTICLES. Kobzev, A. P.; Michalak, S.; Rutkowski, J. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Neutron Physics). 1971. 21p. (In Russian). Dep. NTIS (U. S. Sales Only).

The angular distribution of the transition radiation, excited by nonrelativistic particles when crossing the vacuum-medium boundary, are calculated for different indexes of refraction and the absorption coefficients. (auth)

33596 (LA-4592) THE INTEGRATED COMPTON CROSS SECTION AND ITS USE IN A MONTE CARLO SCHEME. Fraley, Gary S. (Los Alamos Scientific Lab., N. Mex.). Dec 1970. Contract W-7405-eng-36. 18p. Dep. NTIS.

The differential Compton cross section is integrated over a relativistic Maxwellian electron distribution. The result, the cross section per final energy and angle of scatter, is then used in a Monte Carlo scheme that does not involve the use of large tables. (auth)

33597 (NYO-3829-68) PHENOMENOLOGICAL EFFECTIVE LAGRANGIAN AND THE REACTIONS $\gamma + \gamma \rightarrow$ PIONS. Yao, Tsu (Pittsburgh Univ., Pa. Dept. of Physics). Mar 1971. Contract AT(30-1)-3829. 7p. Dep. NTIS.

A phenomenological effective Lagrangian for the annihilation of two photons into pions first suggested previously is generalized. The Lagrangian gives photon annihilation into both even and odd number of pions, and is free from any arbitrary parameter. All production cross sections are found to increase with increasing energies, a feature common to many effective Lagrangian models. Near threshold $\pi^+\pi^-\pi^0$ production is found to be comparable to that of $3\pi^0$ production, while at higher energies the charged mode dominates over the neutral mode, a conclusion somewhat different from that of previous work. It is hoped that at low and medium energies future experiments will be able to test the implications of this simple model. (auth)

33598 SINGLE PRODUCTION OF W BOSON IN COLLIDING ELECTRON–POSITRON BEAMS. Altukhov, A. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: 637-9(Mar 1971). (In Russian).

The total cross sections of the processes $e^+ + e^- \rightarrow W^\pm + \mu^\mp + \overline{\nu}_\mu(\nu_\mu)$ are found. (auth)

33599 PRODUCTION OF NEUTRAL VECTOR MESONS AND OF INTERMEDIATE BOSON IN COLLIDING LEPTON BEAMS. Choban, E. A. (Leningrad Polytechnic Inst.). Yadern. Fiz.; 13: 624-32(Mar 1971). (In Russian).

Production of single neutral vector mesons and of the intermediate boson in colliding lepton beams is considered when the total mass of the initial particles is much more than the mass of the produced particle. Differential and total cross sections of the processes in view are obtained and compared with the previously studied cross sections of the processes of production of the vector mesons and the intermediate boson. The components of the quadrupole polarization tensor of neutral vector mesons are found and it is shown that their dipole polarization equals to zero. (auth)

33600 SINGLE PRODUCTION OF W BOSON IN COLLIDING ELECTRON BEAMS. Altukhov, A. M.; Khriplovich, I. B. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: 633-6(Mar 1971). (In Russian).

The total cross sections of the processes $e^- + e^\pm \rightarrow W^- + e^\pm + \nu$ are found. The Weizsäcker–Williams method used in the calculations is valid in this case due to the fact that the electrons are ultrarelativistic. (auth)

33601 CURRENT-ALGEBRA-LIKE APPROACH TO THE DEEP INELASTIC REGION. Boiti, M.; Donini, E.; Pempinelli, F. (Univ., Lecce, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy). Nuovo Cim.; 3A: 82-92(1 May 1971).

The connection between scale-invariant structure functions of the electron-proton scattering in the deep inelastic region and charge-density commutators at almost equal time is discussed; current algebra features and methods turn out to be relevant in this framework and an infinite set of sum rules is derived. By exploiting the microcausality requirement, certain consequences of scaling amplitudes are obtained, which severely limit the analytical structure of the latter. (auth)

33602 SELF-CONSISTENT DISPERSION-THEORETIC ELECTRON–POSITRON SCATTERING AMPLITUDE. McEnnan,

James (Univ. of Florida, Gainesville). Phys. Rev., D; 3: 1935-45(15 Apr 1971).

A method is outlined for the construction of dispersion-theoretic electromagnetic scattering amplitudes for processes in which bound states may appear; in particular, the electron-positron system is examined. A Lorentz-covariant spinor amplitude is exhibited which is analytic, cutoff independent, and crossing symmetric, which has the correct double-spectral functions through second order in the fine-structure constant α, and which reduces to the usual Born approximation in lowest order. Moreover, the amplitude displays Regge asymptotic behavior and the positronium Regge poles. Self-consistency requires that the positronium poles appear at the correct position and with the proper residue, and that the amplitude possesses a well-defined Jacob-Wick expansion. It is found that this second-order amplitude provides a suitable basis for iterative calculation of the higher-order terms using the same procedure. (auth)

33603 PROTON FORM FACTOR, MAGNETIC CHARGES, AND DYONIUM. Barut, A. O. (Univ. of Colorado, Boulder). Phys. Rev., D; 3: 1747-50(15 Apr 1971).

The relativistic quantum dynamics of two particles having both electric and magnetic charges (e,g) is discussed. It is shown that this model with its strong long-range forces is a physical realization underlying the dipole magnetic form factor $G_M(t)$ of the proton calculated in the relativistic O(4,2) model. The mass spectrum gives a linear trajectory for low values of the principal quantum number N, contains N^2 degeneracy and parity doubling. The slope of the trajectory and the slope of the form factor can be related in principle to the masses of the constituents and the effective electric coupling $\alpha \equiv -(e_1e_2 + g_1g_2)$. (auth)

33604 ELECTRON-NUCLEUS NEUTRINO BREMSSTRAHLUNG. Cazzola, P. (Univ., Ferrara, Italy. Univ., Padua); De Zotti, G.; Saggion, A. Phys. Rev., D; 3: 1722-7(15 Apr 1971).

The neutrino energy rate arising from bremsstrahlung reactions of the type nucleus + e^- → nucleus + e^- + ν + $\bar{\nu}$ is computed in a relativistic context at various densities and temperatures of matter. The density regions of degeneracy, partial degeneracy, and nondegeneracy of the electron sea are considered. It is found that the bremsstrahlung reaction is the dominant neutrino-producing mechanism in the extreme degeneracy region, as previously found by Festa and Ruderman. It dominates also for partial degeneracy if the atomic number Z of the nuclei is not too low and for temperatures lower than $2 - 3 \times 10^{9}$K, while it is negligible in the nondegenerate regions. The results agree very well with those of Festa and Ruderman in the limit of very high densities. The electron-nucleus bremsstrahlung rate is also compared for extreme degeneracy with the electron-electron bremsstrahlung rate, which was studied by two of us in the nondegenerate case. It is shown that e-e collisions give a negligible contribution in comparison with e-nucleus reactions. (auth)

33605 SPIN MAGNETIC MOMENT OF A FREE RELATIVISTIC ELECTRON. Zawadzki, Wlodek (Inst. of Electron Tech., Warsaw). Phys. Rev., D; 3: 1728(15 Apr 1971).

Using eigenvalues of the Dirac equation solved for a uniform magnetic field, it is demonstrated that the spin magnetic moment of a free relativistic electron is $\mu_B(E) = e\hbar/2m\,(E)c$, where m(E) is the Lorentz mass. (auth)

33606 NARROW-RESONANCE DUALITY AND THE CONSPIRACY VERSUS ABSORPTION DISPUTE IN PHOTOPRODUCTION. Roy, D. P. (Univ. of Toronto). Phys. Rev., D; 3: 2283-5(1 May 1971).

On the basis of narrow-resonance duality, it is shown that the finite-energy sum rules for forward photoproduction should be dominated by the resonant or nonresonant part, depending on whether the dominant Regge singularity is a conspiring pole or an absorptive cut. The physical situation clearly favors a conspiracy solution, although not necessarily the one involving conspiracy for the physical pion. Other applications of this approach are outlined. (auth)

33607 TEST OF THE DOMINANCE OF TENSOR-MESON NONET TRAJECTORIES IN SU(3)-SYMMETRY BREAKING. Lee, S. Y. (Univ. of California, Los Angeles). Phys. Rev., D; 3: 2292-4(1 May 1971).

It is shown that the reactions of very-high-energy forward photoproduction of neutral vector mesons off nucleons furnishes a further test of the idea that SU(3)-symmetry breaking is dominated by the nonet of tensor-meson trajectories at zero momentum transfer. (auth)

33608 FINITE-ENERGY SUM RULES AND INELASTIC ELECTRON SCATTERING. Elitzur, Moshe (Rockefeller Univ., New York). Contract AT(30-1)-4204. Phys. Rev., D; 3: 2166-71(1 May 1971).

Finite-energy sum rules (FESR) are used to analyze the inelastic-electron-scattering data. It is shown that the sum of resonances build up a scaling function although each resonance contribution falls off according to a dipole formula. This is achieved by assuming that the dipole mass which enters into the form factor increases when we go to higher resonances. The assumption seems to be confirmed by the data. The contribution of the Regge trajectories to the FESR is also investigated, assuming that they all scale. It is found that the equations can be satisfied only if there is another contribution of a J = 0 fixed pole. The residue function of the fixed pole is calculated explicitly and compared with that of the fixed pole found at real Compton scattering. The two residue functions are found to have opposite signs. (auth)

33609 STUDY OF THE DECAY $\omega \to \pi\pi\gamma$. Levy, Naomi; Singer, Paul (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 3: 2134-47(1 May 1971).

The effect of π-π interaction in isospin-zero states on the characteristics of the $\omega \to \pi\pi\gamma$ decay is investigated by means of partial-wave dispersion relations. With the ρ-exchange contribution as the driving term and elastic unitarity for π-π scattering on the right-hand cut, integral equations whose solutions explicitly depend on the π-π phase shift are obtained. Various scattering-length and resonance models are used to represent the π-π phase shift. The high-energy contribution to the integral equation is treated in three ways: by subtraction, adding an effective pole on the left-hand cut, and normalizing the amplitude at the f_0 resonance to a Veneziano model for $\omega \to \pi\pi\gamma$. Numerical results for rate and spectrum are discussed in the light of the possibility of discriminating by experimental results among the various models for π-π interaction. (auth)

33610 ENERGY DEPENDENCE OF THE REACTION $\gamma p \to \rho^-\Delta^{++}$. Ballam, J. (Stanford Univ., Calif.); Chadwick, G. B.; Levy, A.; (and others). Phys. Rev. Lett.; 26: 995-7(19 Apr 1971).

The reaction $\gamma p \to \rho^-\Delta^{++}$ was studied between 4 and 8 GeV using positron-annihilation radiation. Assuming $\sigma \propto E^{-\alpha}$ it is found that $a = 0.6 \pm 0.2$. With sufficiently large absorption corrections, a one-pion-exchange model can fit this dependence, but requires a width for $\rho \to \pi\gamma$ much in excess of the value predicted by SU(3). (auth)

33611 INTERPRETATIONS OF SINGLE π^+ ELECTROPRODUCTION DATA AND A DETERMINATION OF THE PION FORM FACTOR. Brown, C. N.; Canizares, C. R.; Cooper, W. E.; (and others). (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev. Lett.; 26: 991-4(19 Apr 1971).

New data on forward π^+ electroproduction are in reasonable agreement with the predictions of a dispersion-theory calculation by Berends. This model is used to extract the pion electromagnetic form factor. The result is consistent with $F_\pi = F_1^V$, but a simple ρ-pole form factor cannot be ruled out. (auth)

33612 COINCIDENCE MEASUREMENTS OF SINGLE π^+ ELECTROPRODUCTION. Brown, C. N.; Canizares, C. R.; Cooper, W. E.; (and others). (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2752. Phys. Rev. Lett.; 26: 987-91(19 Apr 1971).

The reaction $e^- + p \to e^- + \pi^+ + n$ was studied by detecting the final electron and pion in coincidence. Data are presented in the region of virtual photon mass squared from -0.18 to -1.2 GeV^2, and virtual photoproduction center-of-mass energy and angle from 1.85 to 2.50 GeV and 0 to 20°, respectively. (auth)

33613 ELECTROPRODUCTION SUM RULE. Segre, Gino (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 26: 796-7(29 Mar 1971).

A new sum rule is presented which relates the nucleon form factor to the integral over energy of the inelastic cross section of nucleons by charged vector currents. (auth)

33614 LIGHT-CONE EXPANSIONS FOR EXCLUSIVE PROCESSES. Frishman, Y.; Rittenberg, V.; Rubinstein, H. R.; Yankielowicz, S. (Weizmann Inst. of Science, Rehovot, Israel). Phys. Rev. Lett.; 26: 798-801(29 Mar 1971).

It is shown that light-cone dominance ideas apply to exclusive processes as well. These processes must include a photon of large virtual mass, as for example deep pion electroproduction. The method provides for a new general parametrization for amplitudes in the Bjorken limit. If correct, it will lend strong support to the ideas of light-cone expansions of operator products and provide a way to study the structure, at short distances, of the commutators of electromagnetic currents and strong sources. (auth)

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33615 CALCULATION OF npγ CROSS SECTIONS AND ASYMMETRIES. McGuire, J. H.; Pearce, W. A. (Texas A and M Univ., College Station). Nucl. Phys.; A162: 573-82(1971).

Neutron-proton bremsstrahlung cross sections and asymmetries are calculated in both the Gottschalk and Thorndike geometries. The influence of off-shell terms is determined by comparing off-shell calculations to calculations using only elastic scattering parameters. The npγ asymmetry is generally less sensitive to off-shell terms than the corresponding cross section. However, the off-shell influences in the npγ cases are greater than in the corresponding ppγ cases. Furthermore, the npγ cross sections tend to be large in the same region where the interesting off-shell effects are large. (auth)

33616 CALCULATION OF ppγ CROSS SECTIONS AND ASYMMETRIES. McGuire, J. H.; Pearce, W. A. (Texas A and M Univ., College Station). Nucl. Phys.; A162: 561-72(1971).

Proton-proton bremsstrahlung cross sections and asymmetries are calculated in both the Gottschalk and Thorndike geometries. Calculations using model-dependent off-shell terms are compared to calculations where these terms are suppressed. In general, the ppγ asymmetries are less sensitive to off-shell information than the corresponding ppγ cross sections. These calculations also indicate that the asymmetry at 204 MeV is smoother than the Rochester experiment suggests. Calculations of the ppγ cross section at extreme forward angles in the Gottschalk geometry suggest large model-dependent effects. (auth)

33617 SCHWINGER TERMS AND ANNIHILATION $e^+ + e^- \rightarrow$ HADRONS DUE TO THE VECTOR MESON CURRENT. Ioffe, B. L.; Khoze, V. A. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 381-91(Feb 1971). (In Russian).

High energy asymptotics of the total cross section of the annihilation $e^+ + e^- \rightarrow$ hadrons, $\sigma(E)$, is considered assuming that the electromagnetic hadron current j_μ is a sum of the charged vector meson current, spin = ½ fermion current, and spinless boson current. The asymptotics of $\sigma(E)$ is determined by the value of the Schwinger term—the vacuum averaged equal-time commutator, $\langle 0|[j_0(x), j_i(0)]|0\rangle_{x_0=0}$. It is shown that in case of the vector meson current the Schwinger approach can not be used to calculate the commutator as the result would be in contradiction with the spectral representation. A method is presented to calculate the commutator in view by means of integration in the momentum space that has no inconsistencies of this sort. The asymptotics of the annihilation cross section at $E \rightarrow \infty$ is obtained: $\sigma(E) \rightarrow \text{const}/E^\gamma$, with $2 \geq \gamma \geq 0$. (auth)

33618 PION PHOTO- AND ELECTROPRODUCTION ON PROTON IN THE NEAR-THRESHOLD REGION. Omelaenko, A. S. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 363-8(Feb 1971). (In Russian).

Experimental data on the measurement of the cross section of the reaction $\gamma p \rightarrow n\pi^+$ in the near-threshold region are analyzed in terms of the resonance model. The obtained parameters of Δ-isobar contribution are then used to estimate the effect of the neutron charge form factor, G_{En}, and the pion form factor F_π on the cross section of reaction $ep \rightarrow e'n\pi^+$. (auth)

33619 INVESTIGATION OF HIGH-ENERGY γγ SCATTERING WITH COLLIDING ELECTRON BEAMS. KINEMATICS AND ESTIMATES OF THE CROSS SECTIONS. Budnev, V. M.; Ginzburg, I. F. (Inst. of Mathematics, Kiev). Yadern. Fiz.; 13: 353-62 (Feb 1971). (In Russian).

Hadron production by two bremsstrahlung photons may be observed at accelerators with colliding e^+e^- or e^-e^- beams. The γγ-system c.m.s. energy, s, may be large, and the total cross section increases as a logarithm of the beam energy mounting up to 10^{-33} cm² at GeV energies. The relation of the observed cross sections to the γγ forward scattering amplitudes is established in the helicity representation and in the invariant formalism. The possibility of measuring these quantities with their dependence on s and on the virtual photon masses is estimated. (auth)

33620 RADIATIVE CORRECTIONS TO CROSS SECTION OF THE DOUBLE BREMSSTRAHLUNG. Baier, V. N.; Geidt, V. V. (Novosibirsk State Univ., USSR). Yadern. Fiz.; 13: 350-2(Feb 1971). (In Russian).

Radiative corrections to the cross section of the double bremsstrahlung are found for high-energy electron collision in soft photon approximation. (auth)

33621 π^0-MESON PHOTOPRODUCTION ON ^{12}C. Gur'ev, V. N. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 326-31(Feb 1971). (In Russian).

The numerical calculation is performed for differential cross sections of π^0-meson elastic photoproduction on ^{12}C nucleus in the photon energy region (in lab. system) 160 to 440 MeV and meson emission angle (in c.m.s.) 10 to 140°. The calculation is performed in "relativistic impulse approximation" with the form factor of the ^{12}C nucleus calculated in generalized shell model with the mean-squared radius 2.00; 2.20 and 2.42 f. Within the energy region 160 to 190 MeV the model is very critical to the choice of a variant of the multipole analysis of the pion–nucleon photoproduction. The analysis of the experimental data at the photon energy 154, 182, and 250 MeV is given in the framework of elastic two-particle unitarity. (auth)

33622 SPIN DEPENDENCE IN INCLUSIVE COLLISIONS. Abarbanel, Henry D. I.; Gross, David J. (Princeton Univ., N. J.). Contracts AT(30-1)-4159; AF49(638)-1545. Phys. Rev. Lett.; 26: 732-4(22 Mar 1971).

Polarization phenomena in inclusive reactions are shown to exhibit remarkably simple features from the point of view of J-plane physics with factorizable singularities. In particular, straightforward tests of factorization are proposed in single- and multiple-particle inclusive experiments initiated with polarized photon beams–real and virtual–or polarized proton targets. (auth)

33623 NEW EXPERIMENTAL TEST OF COULOMB'S LAW: A LABORATORY UPPER LIMIT ON THE PHOTON REST MASS. Williams, E. R.; Faller, J. E.; Hill, H. A. (Wesleyan Univ., Middletown, Conn.). Phys. Rev. Lett.; 26: 721-4(22 Mar 1971).

A high-frequency test of Coulomb's law is described. The sensitivity of the experiment is given in terms of a finite photon rest mass using the Proca equations. The null result of our measurement expressed in the form of the photon rest mass squared is $\mu^2 = (1.04 \pm 1.2) \times 10^{-10}$ cm^{-2}. Expressed as a deviation from Coulomb's law of the form $1/r^{2+q}$, our experiment gives $q = (2.7 \pm 3.1) \times 10^{-16}$. This result extends the validity of Coulomb's law by two orders of magnitude. (auth)

33624 CHERENKOV ENERGY LOSS OF CHARGED TACHYONS. Wimmel, H. K. (Max-Planck Institut fuer Plasmaphysik, Garching, Ger.). Lett. Nuovo Cim.; 1: No. 15, 645-50 (10 Apr 1971).

An intensity formula for the Cherenkov radiation of tachyons in vacuo was previously obtained by Alvaeger and Kreisler (Phys. Rev., 171, 1357 (1968)). It is shown that the formula is not valid and that it does not give any indication of the actual rate of Cherenkov energy loss. In addition, some general results are derived that must hold for Cherenkov radiation and energy loss by tachyons moving in vacuo. The possibility of charged tachyons being forbidden and the consequences are briefly discussed. The principles of relativity, macrocausity for light signals, Lorentz covariance, and Maxwell's equations are used. (L.B.S.)

33625 SOME PROCESSES IN QUANTUM ELECTRODYNAMICS AT HIGH ENERGIES. Lipatov, L. N.; Frolov, G. V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: 588-99(Mar 1971). (In Russian).

The asymptotics of the eγ, γγ, ee and Delbrueck scattering processes is considered in the order of the perturbation theory that contributes to the part of the scattering amplitude proportional to s, $\sqrt{s}$ being the c.m. energy. The Sudakov method was used to calculate the asymptotics of the Feynman graphs. The scattering amplitudes are calculated at the momentum transfer values $q \sim 1$, as well as in the region $q \sim s^{-1} \ll 1$, the results for the $q \sim 1$ region being the same as those by Cheng and Wu. The result for the Delbruck scattering differs from the well known Bethe–Rohrlich formula. Inelastic processes are also discussed. It is noted that at high energies the double Compton effect is more important than the simple Compton scattering and that the photoproduction of two pairs is more than the production of one pair. An analytic expression is obtained for the total production cross section of two pairs. (auth)

33626 STUDY OF POTENTIAL SCATTERING IN THE FRAMEWORK OF THE DIRAC ELECTRON THEORY. Barthelemy, Marie-Claire (Univ., Poitiers, France. Univ., Paris). Ann. Inst. Henri Poincare, Sect. A; 14: No. 1, 57-67(1971). (In French).

The asymptotic behavior of phase shifts is investigated when the real eigenvalue x increases indefinitely. An explicit expression is given for a potential of exponential type $V(r) = r^m e^{-\alpha r}$, with $\alpha > 0$ and m a nonnegative integer. A property of the square of the modulus of $(kr)^x k h_\chi^-(kr)$, is given. (France)

33627 SCATTERING OF PARTICLES BY MAGNETIC INHOMOGENEITIES IN A STRONG MAGNETIC FIELD. Gal'perin, B. A.; Toptygin, I. N.; Fradkin, A. A. (Leningrad Polytechnic Inst.). Zh. Eksp. Teor. Fiz.; 60: No. 3, 972-81(Mar 1971). (In Russian).

An equation is derived which describes multiple scattering of particles by random magnetic pulsations in a strong magnetic field. Approximate solutions of the equation are found in a number of cases, including that of an inhomogeneous field. The time intervals and distances over which isotropization of the particle beam occurs are estimated. A consequence of scattering anisotropy is that the time for scattering of particles into an angle $\vartheta \sim \pi$ may considerably exceed the time for scattering into an angle $\vartheta \sim 1$. Scattering of cosmic ray particles in interplanetary space is considered on basis of the results obtained. (auth)

33628 PHOTON GREEN FUNCTION IN A STATIONARY HOMOGENEOUS FIELD OF THE MOST GENERAL FORM. Batalin, I. A.; Shabad, A. E. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz.; 60: No. 3, 894-900(Mar 1971). (In Russian).

Restrictions imposed by Lorentz, gauge and charge invariance are employed for specifying the covariant structure of the photon polarization tensor in the presence of an external electromagnetic field with a time and space-independent intensity tensor. The photon polarization tensor is represented in diagonal form. The photon Green function is expressed in terms of the polarization tensor in a general form by solving the Dyson equation. The Maxwell equations in the external field are also solved in a general form. The photon polarization tensor is calculated in the loop approximation, exact Green functions of the Dirac equation being adopted for the electron propagators in the loop. (auth)

33629 HADRON PRODUCTION IN e^+e^- COLLISIONS AND THE EXISTENCE OF NEW VECTOR MESONS. Bramon, A.; Greco, M. (CNEN, Frascati, Italy). Lett. Nuovo Cim.; 1: No. 18, 739-42 (1 May 1971).

The existence of a meson ρ' having the quantum numbers of the ρ is assumed, and some consequences of its existence are discussed. The situation concerning the decays of the known pseudoscalar and vector mesons is first examined, taking into account the contributions of the ρ' and its SU(3) partners. An estimate is made of how the new mesons couple to the photon and to the old ones. The cross sections for production of hadrons in e^+e^- collisions are then studied and the magnitude and behavior at total energies of the colliding beams ranging from 1.4 to 2.4 GeV are predicted. (L.B.S.)

33630 CANONICAL THEORY OF THE TWO-BODY PROBLEM IN THE CLASSICAL RELATIVISTIC ELECTRODYNAMICS. Staruszkiewicz, Andrzej (Jagellonian Univ., Krakow). Ann. Inst. Henri Poincare, Sect. A; 14: No. 1, 69-77(1971).

Two charged particles of finite mass are considered and it is assumed that the first particle moves in the retarded field of the second one, while the second particle moves in the advanced field of the first one. Equations of motion for this system are not differential-difference equations, as is the case in other conceivable two-body problems, but can be reduced to ordinary differential equations. The main result of this paper is derivation of the Euler homogeneity relation expressed by means of momenta. (France)

33631 FINE-STRUCTURE CONSTANT $\alpha = e^2/hc$ AS A UNIVERSAL SCALING FACTOR. MacGregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 1: No. 18, 759-64 (1 May 1971).

The ideas that the fine structure constant $\alpha = 1/137$ somehow connects the hadronic and leptonic mass spectra are extended to establish a phenomenological relationship between α and leptonic processes, and possibly also between α and gravitational processes. A scaling in powers of α is also used to postulate a relation between stellar densities and the sizes of elementary particles. (L.B.S.)

33632 DEEP INELASTIC ELECTRON-HADRON SCATTERING IN THE FISHING-NET DIAGRAM APPROACH. Muta, T. (Kyoto Univ.); Shimizu, Y. Lett. Nuovo Cim.; 1: No. 18, 765-9(1 May 1971).

The structure functions for inelastic scattering of electrons from charged scalar mesons are calculated in the framework of the parton model and by adopting the conjectured correspondence between the dual-resonance model and the very-high-order Feynman diagrams for virtual Compton scattering. (L.B.S.)

33633 RESONANCE MULTIPOLES IN COMPTON SCATTERING ON ^{4}He NUCLEI. Alimov, A. D.; Usmanov, T. M. (Inst. of Nuclear Physics, Tashkent). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 70-5(1970). (In Russian).

Contributions of various resonances to the Compton scattering on ^{4}He from the threshold of π-meson photoproduction to 1200 MeV was studied using the method of relativistic pulsed approximation. The isobar model for describing experimental data on π-meson photoproduction was used for describing multipole amplitudes contributing to the γ-^{4}He scattering. The studied process was described by a diagram taking into account only the first abnormality in the momentum transmission within the limits of relativistic pulsed approximation. Numerical calculations for the angle of scattering at 90° for γ ^{4}He$-\gamma$ ^{4}He processes with the resonance amplitude contributions percentage of total differential scattering for M_{33}, E_{11}, M_{11}, E_{13}, E_{15}, E_{31}, M_{15}, and E_{11} at multipolarity up to 1.2 GeV was tabulated. Data obtained showed that at 600 MeV the contribution of E_{11} and M_{11} multiples prevailed in the differential cross section and at 1000 to 1100 MeV multipoles M_{15} and E_{11} contribute considerably along with the known resonance multipole E_{15}. (R.V.J.)

33634 LASER-INDUCED MULTIPHOTON PROCESSES IN e^--p SCATTERING. Brehme, Helmut (Univ., Freiburg i. B.). Phys. Rev., C; 3: 837-40(Feb 1971).

In order to obtain information about the role of multiphoton processes in recently reported laser-induced nuclear fusion, the cross section for simultaneous net absorption of n photons by a system of two point charges was calculated numerically for e^--p scattering in a ruby laser beam at an incident relative energy of 100 eV. The results show that at laser intensities involved in fusion experiments multiphoton processes apparently play an important role, partly contributing to the same order within certain n intervals. (auth)

33635 ASYMPTOTIC RELATIONS AMONG BARYON FORM FACTORS IN THE SU(3) SYMMETRY MODEL. Abdel-Rahman, A.-M. M. (Univ. of Liverpool). Nucl. Phys.; B29: 169-88 (1971).

Asymptotic relations among form factors of the Σ-baryon derived in an earlier note are reexamined in the limit of SU(3) symmetry. A relation between Σ-vector and axial-vector form factors is found to be modified by the appearance of terms containing $\Sigma-\Lambda$ electromagnetic and weak axial form factors. A second relation involving Σ Sachs isovector electric and magnetic form factors reappears, but only as one of two conditions at least one of which must hold if consistency of the approach is to be ensured. The second condition requires that the F/D ratio for the axial current in the baryon octet should satisfy $(F/D)^2 = 1/3$, which is exactly what emerges on saturating certain dispersion sum rules with common-mass baryons of the SU(3) octet representation. Two additional asymptotic relations, one relating isoscalar magnetic form factors and the other connecting induced pseudoscalar form factors are also obtained. (auth)

33636 GENERALIZED VENEZIANO MODEL FOR CHARGED PION PHOTOPRODUCTION. Reya, E. (Daresbury Nuclear Physics Lab., Eng.). Nucl. Phys.; B29: 189-203(1971).

Charged pion photoproduction is investigated in the framework of Veneziano B_5 amplitudes using Sugawara's "spurion" technique in order to introduce fixed J-plane poles. The Regge exchanges are taken to be evasive. The agreement with experiment for the differential cross section, the π^-/π^+ ratio and the polarization asymmetries for photon energies between 3.4 and 18 GeV is quite reasonable. (auth)

33637 LIGHT CONE AS SEEN IN THE GLUON MODEL. Zee, A. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 3: No. 10, 2432-41(15 May 1971).

To second order in a gluon model, the longitudinal electroproduction function respects scaling and thus provides a laboratory for the study of various light-cone theorems recently derived in the literature. In particular, the operator-Schwinger-term sum rule is upheld by a hitherto unsuspected singularity at $\omega (\equiv -q^2/2\nu) = 0$ which may obliterate any direct connection between light-cone singularities and electroproduction experiments. The use of causal representations in the literature of deep inelastic processes is also discussed emphasizing the delicacy of popular techniques. (auth)

33638 RELATIVISTIC QUANTUM MECHANICS OF DYONS. EXACT SOLUTION. Bialynicki-Birula, I. (Univ. of Pittsburgh. Univ., Warsaw). Phys. Rev., D; 3: No. 10, 2413-15(15 May 1971).

A relativistic quantum mechanics of dyons (hypothetical particles endowed with both electric and magnetic charges) is formulated. The hydrodynamic formulation of quantum mechanics is used to overcome all problems created by the simultaneous presence of both electric and magnetic charges. In the case of one dyon moving in the electromagnetic field of another dyon the exact solutions are found and the energy levels are determined. (auth)

33639 MAGNETIC MONOPOLES IN THE HYDRODYNAMIC FORMULATION OF QUANTUM MECHANICS. Bialynicki-Birula, I. (Univ. of Pittsburgh. Univ., Warsaw); Bialynicka-Birula, Z.

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Contract AT(30-1)-3829. Phys. Rev., D; 3: No. 10, 2410-12 (15 May 1971).

The nonrelativistic quantum theory of a particle having both electric and magnetic charges moving in an arbitrary external electromagnetic field is presented. The theory is based on the hydrodynamic formulation of quantum mechanics. Dirac's quantization condition for the electric and magnetic charges is rederived as a consistency condition for the motion of the probability fluid. Neither the wave function nor the electromagnetic potential, which were the source of ambiguities in all other formulations, appears in our approach. Nevertheless, this theory has all the essential features of the standard quantum mechanics, including the superposition principle. (auth)

33640 s-CHANNEL HELICITY IN COMPTON SCATTERING. Ebata, T. (Tohoku Univ., Sendai); Sakuraoka, M.; Akiba, T. Lett. Nuovo Cim.; 1: No. 20, 809-13(15 May 1971).

It is shown that a simple parametrization for Regge poles, compatible with all kinematical constraints at threshold and pseudothreshold, leads to helicity conservation in virtual Compton scattering, and that the parametrization seems to be connected with the fixed pole at the nonsense wrong-signature point in purely hadronic processes. It is suggested that the study of the virtual photon process may be very useful for studying spin effects. (L.B.S.)

33641 POSSIBILITY OF OBTAINING HIGH-ENERGY POLARIZED ELECTRONS AND POSITRONS. Avakyan, R. O.; Iskandaryan, A. G. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 275-8(1970). (In Russian).

A possibility of obtaining high energy polarized electrons and positrons by circular polarized photons obtained from bremsstrahlung, using interference phenomena in electron-positron pair production in a crystal, is described. (auth)

33642 DETERMINATION OF PARTICLE PARITY IN EXPERIMENTS WITH COLLIDING BEAMS. Khoze, V. A. (Inst. of Physics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz.; 5: 338-41(1970). (In Russian).

The methods of determining the intrinsic parities in reactions $e^+e^- \to \alpha_1 + \alpha_2$ are discussed. The methods are based on the invariance with respect to rotations and reflections and on the conservation of helicity of ultrarelativistic electrons. (auth)

33643 COMMENTS ON THE CLASSICAL THEORY OF MAGNETIC MONOPOLES. Miller, D. T. (University Coll., London). Proc. Cambridge Phil. Soc.; 69: 449-56(May 1971).

The classical theory of electromagnetism with both electric and magnetic charges is discussed. Proceeding from an action principle the resulting particle equations are investigated. A consistent theory in which electrically and magnetically charged particles interact among themselves and with each other, without any constraints, is shown to be possible, in contrast to previous conclusions. The introduction of constraints is considered. (auth) (UK)

33644 FIXED POLES AND LIGHT CONE SINGULARITIES. Mack, G. (Univ., Munich). Phys. Lett.; 35B: No. 3, 234-8 (24 May 1971).

Deviations from strictly canonical light cone singularities of the e.m. current commutator, such as logarithmic factors or fractional power behavior could, in principle, be detected by looking for $J \approx 0$ fixed pole contributions to the imaginary part of the Compton amplitude in the Regge limit, i.e. electroproduction structure function W_2 and total photoabsorption cross section. (auth)

33645 PHOTOPRODUCTION ON NUCLEI AND DETERMINATION OF MULTIPOLE AMPLITUDES ABOVE THE NEAR-THRESHOLD ENERGY REGION. Rej, A. K. (Indian Statistical Inst., Calcutta). Lett. Nuovo Cim.; 1: No. 21, 882-4(22 May 1971).

Measurements of the elastic differential cross sections for π^0 photoproduction on complex nuclei like ^{12}C and ^{16}O above 230 MeV along with the measurement of the inelastic differential cross section for π^0 photoproduction on ^9Be leading to the second excited state at 2.43 MeV are suggested for the empirical determination of the multipole amplitudes in this energy region. (L.B.S.)

33646 PHOTOPRODUCTION ON SPIN-ZERO NUCLEI AND DETERMINATION OF MULTIPOLE AMPLITUDES AT THE NEAR-THRESHOLD ENERGY REGION. Rej, A. K. (Indian Statistical Inst., Calcutta). Lett. Nuovo Cim.; 1: No. 21, 876-81(22 May 1971).

The multipole amplitudes contributing to π^0 photoproduction on spin-zero nuclei below 230 MeV are determined empirically from elastic differential cross section data without using the value of any multipole amplitude from dispersion theory. (L.B.S.)

33647 PHENOMENOLOGICAL EFFECTIVE LAGRANGIAN AND THE REACTIONS $\gamma + \gamma \to$ PIONS. Yao, Tsu (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Lett.; 35B: No. 3, 225-6(24 May 1971).

A phenomenological effective Lagrangian for the annihilation of two photons into pions first suggested by Aviv, Dass and Sawyer is generalized. The Lagrangian gives photon annihilation into both even and odd number of pions, and is free from any arbitrary parameter. All production cross sections are found to increase with increasing energies, a feature common to many effective Lagrangian models. Near threshold $\pi^+\pi^-\pi^0$ production is found to be comparable to that of $3\pi^0$ production, while at higher energies the charged mode dominates over the neutral mode, a conclusion somewhat different from that of ADS. It is hoped that at low and medium energies future experiments will be able to test the implications of this simple model. (auth)

33648 POMERANCHUK TRAJECTORY AND J = 1 FIXED POLES IN VIRTUAL COMPTON AMPLITUDE. Miranskii, V. A.; Shelest, V. P.; Zinovjev, G. M. (Inst. for Theoretical Physics, Kiev). Phys. Lett.; 35B: No. 3, 222-4(24 May 1971).

Analyzing the "wrong" FESR for the virtual Compton amplitude $t_2(\nu,q^2)$ the conclusion is reached that the Pomeranchukon residue decreases as $1/\ln Q^2$ or faster, with $Q^2 = -q^2 \to \infty$ and that in t_2, irrespective of the Pomeranchukon, there are J = 1 fixed poles with isospins I = 0 and I = 1. (auth)

Weak

33649 (LPTHE-TH-71/12) NEW RESULTS IN THE QUARK PARTON MODEL. Nachtmann, O. (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Feb 1971. 22p. Dep. NTIS.

The quark parton model for deep inelastic lepton-hadron scattering is analyzed using the powerful tools of SU(3)-invariance and positivity. It is found that the model predicts the structure functions for electro- and neutrino production to lie in certain positivity domains, which are given explicitly. A comparison with available data and predictions for neutrino experiments are made. (auth)

33650 (NP-18821) LECTURES ON WEAK INTERACTIONS. Sirlin, Alberto (New York Univ., N. Y. Dept. of Physics. Instituto Politecnico Nacional, Mexico City. Centro de Investigacion y de Estudios Avanzados). [nd]. 191p.

Notes compiled by Arnulfo Zepeda and Ramon Suarez.

These lectures cover V−A theory, a search for the correct phenomenological interaction, the conserved vector current hypothesis, SU(3) theory of semileptonic decays, partially conserved axial vector current, current algebra and applications to semi-leptonic decays, and nonleptonic decays. (J.F.P.)

33651 RECOIL ELECTRON SPECTRUM IN ELASTIC $\bar{\nu}_e e$ SCATTERING. Grigoryan, G. V.; Shchepkin, M. G. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 640-4(Mar 1971). (In Russian).

The restrictions on the recoil electron spectrum shape in elastic process $\bar{\nu}_e + e^- \to \bar{\nu}_e + e^-$ are obtained assuming the locality of the Lagrangian of $e\nu$ interaction. A possibility is discussed of determining the tensor structure of interaction from the shape of the recoil electron spectrum. (auth)

33652 PHOTON LOW-ENERGY THEOREM AND THE RADIATIVE DECAYS OF THE Ω-PARTICLE. Ram Mohan, L. R. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1428. Phys. Rev., D; 3: 2148-52(1 May 1971).

The photon low-energy theorem due to Low, and to Adler and Dothan is applied to the two-body radiative decays of the Ω^- particle. The decay amplitudes are evaluated in the resulting pole model. With the usual assumptions of octet dominance and CP invariance for the weak Hamiltonian, it is shown that the parity-violating amplitude for $\Omega^- \to \Xi^{*-}\gamma$ should be zero for a current × current weak interaction. The weak vertex parameters obtained from a fit to the experimental data on the nonleptonic decays of the hyperons are used to estimate the decay amplitudes and the decay rates. The implications of the results obtained earlier by Raszillier and Burlacu on the three-body radiative decays $\Omega^- \to B_8 + P + \gamma$ are discussed. Theoretical estimates for the decay rates of weak decay modes of the Ω^- particle have been compiled. (auth)

33653 CONSISTENCY OF HARD-PION THEOREMS IN K_{l3} DECAYS. Olshansky, Robert; Kang, Kyungsik (Brown Univ., Providence). Phys. Rev., D; 3: 2094-9(1 May 1971). (NYO-2262TA-233).

The K_{l3} scalar form factor is studied by the hard-pion method in the framework of a (3,3*) + (3*,3)-symmetry-breaking model using a modified pole-dominance approximation. A set of con-

sistency relations is found which provides a test of the reliability of the quadratic-smoothness assumption as well as of the symmetry-breaking model. In particular, it is found that the solution for the symmetry-breaking parameters which fit the data is inconsistent with the quadratic-smoothness assumption. In addition, the status of other theoretical models is briefly reviewed. (auth)

33654 VAN HOVE MODEL AND NONLEPTONIC HYPERON DECAYS. Goswami, D. N.; Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.). Phys. Rev., D; 3: 2128-34(1 May 1971).

An attempt is made to construct a pole model for nonleptonic decays where exchanged particles of all spins are included. Summation over the different spins is carried out by means of the Van Hove model, assuming that the Regge-pole term is important. It is found that a number of trajectories do not contribute for a very simple, essentially kinematical reason. A discussion of some consequences of this approach is given. (auth)

33655 RIGOROUS BOUND ON K_{l3} DECAY AMPLITUDES. Li, Ling-fong; Pagels, Heinz (Rockefeller Univ., New York). Contract AT (30-1)-4204. Phys. Rev., D; 3: 2191-5(1 May 1971).

A rigorous bound on the K_{l3} decay form factors $f_i(t)$ is derived. With $\xi \equiv f_-(0)/f_+(0)$ and $\lambda_+ \equiv m_\pi^2 f_+'(0)/f_+(0)$, the bound is $|\xi + (m_{K^\pm}^2 - m_{\pi^\pm}^2)\lambda_+/m_{\pi^\pm}^2| \leq 8\Delta^{1/2}(0)I^{1/2}/\sqrt{3}m_K|f_+(0)|$, where $I = 0.584$ and $\Delta(0)$ is the propagator of the divergence of the strangeness-changing current at zero momentum. If one further assumes for the Hamiltonian density $H(x) = H_0(x) + \epsilon_\beta S_\beta(x) + \epsilon_\delta S_\delta(x)$, with $H_0(x)$ SU(3) × SU(3) invariant and $S_{\beta,\delta}$ transforming like members of the $(\bar{3},3) + (3,\bar{3})$ representation, then one can prove that $\Delta(0) = 3\epsilon_\beta\langle S_\beta\rangle_0/4$, so $\Delta(0)$ is proportional to the product of SU(3) violations in the Hamiltonian times those in the vacuum, and is hence expected to be very small. $\Delta^{1/2} \sim m_\pi f_\pi$ is estimated, and the bound implies $|\xi + 12.3\lambda_+| \leq 0.29$. With $\lambda_+ = 0.06$ as indicated by recent data, $-1.03 < \xi < -0.45$ is obtained, which serves to restrict the ξ value considerably. Remarks are made on the relation of this bound to the perturbative theorem of Dashen and Weinstein. (auth)

33656 DECAY MODES OF HEAVY LEPTONS. Sakurai, J. J. (Univ. of California, Los Angeles). Lett. Nuovo Cim.; 1: No. 15, 624-6(10 Apr 1971).

It is pointed out that the results of a recent unsuccessful search for charged heavy leptons in electron–positron collisions do not rule out the existence of a relatively low-mass heavy lepton which interacts symmetrically in the current–current interaction. The branching ratio for $h^- \to \pi^- + \nu_h/h^- \to e^- + \bar{\nu}_e + \nu_h$ is predicted for a mass $m_h = 600$ MeV. (L.B.S.)

33657 MEASUREMENT OF THE K_L^0 MEAN LIFE. Vosburgh, Kirby G. (Rutgers–The State Univ., New Brunswick, N. J.); Devlin, Thomas J.; Esterling, Robert J.; (and others). Phys. Rev. Lett.; 26: 866-7(5 Apr 1971).

The K_L^0 mean life was measured to be $(5.154 \pm 0.044) \times 10^{-8}$ sec. (auth)

33658 SEARCH FOR $\mu^+ \to e^+ + \gamma$ DECAY. Korenchenko, S. M.; Koston, B. F.; Mitsel'makher, G. V.; Nekrasov, K. G.; Smirnov, V. S. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 341-3(Feb 1971). (In Russian).

The decay $\mu^+ \to e^+ + \gamma$ was searched by using a cylindrical spark chamber placed into a magnetic field. It was found that $W(\mu^+ \to e^+ + \gamma)/W(\mu^+ \to e^+ + \nu_e + \bar{\nu}_\mu) \leq 2.9 \cdot (10)^{-8}$ with 90% confidence level. (auth)

33659 TEST OF LEPTON QUANTUM NUMBERS BY MUON CAPTURE. Kisslinger, Leonard S. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev. Lett.; 26: 998-1000(19 Apr 1971).

It is shown that the $\Delta Q = 2$ semileptonic process can be tested by experiments on muonic atoms. The Δ resonances in nuclear ground states will lead to a $\mu^- \to e^+$ reaction presently observable if the $\Delta Q = 2$, $\Delta S = 0$ interaction is within about two orders of magnitude of the ordinary strangeness-conserving interactions. The consequences for various lepton schemes are discussed. (auth)

33660 FRAGMENTATION MODELS FOR INELASTIC LEPTON–HADRON SCATTERING. Nieh, H. T.; Wang, Jiunn-ming (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev. Lett.; 26: 1139-43(3 May 1971).

Models are proposed for deep inelastic lepton-hadron scatterings, incorporating the general ideas of the fragmentation picture. Approximate scaling behavior can be accommodated at present values of the momentum transfer. But at larger momentum transfers, significant deviations from scaling are expected. In contrast to the results of the parton model, a scaling behavior for the average multiplicity and the structure functions at fixed multiplicities is not possible, according to the fragmentation picture. Results of the model regarding the average multiplicity and the structure functions are presented. (auth)

33661 SPECULATIVE DETERMINATION OF THE INTERMEDIATE-BOSON MASS. Lee, T. D. (Columbia Univ., New York). Phys. Rev. Lett.; 26: 801-4(29 Mar 1971).

It is shown that the algebra generated by the space integrals of the fourth components of the electromagnetic current and the weak-interaction current is that of an SU(2) ⊗ U(1) group. Let $\vec{K}$ be the generator of this SU(2) group. By requiring the $|\Delta\vec{K}| = 1$ part of these current operators, including their respective coupling constants, to form a $\vec{K} = 1$ triplet, it is found that the semiweak coupling constant g is related to the fine-structure constant α by $(4\pi)^{-1}g^2 = \frac{1}{8}\alpha$; therefore, in the absence of radiative corrections, the mass of the (hypothetical) spin-1, charged intermediate boson is 37.29 GeV.

33662 RENORMALIZABLE THEORY OF THE WEAK INTERACTION. Shabalin, E. P. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 411-23(Feb 1971). (In Russian).

Renormalizable theory of the weak interaction is formulated possessing the following properties: at low energies for lepton and lepton-hadronic processes there are results coinciding with predictions of the conventional theory; at high energies a correct asymptotics, as a consequence of renormalizability, appears for cross sections of scattering processes involving leptons; P violation both for the processes with real neutrinos and for nonleptonic processes is only due to the fact that the neutrino is two-component; the $\Delta T = \frac{1}{2}$ rule for nonleptonic processes arises from the theory; the theory permits weak CP violation. (auth)

33663 LIMITS OF APPLICABILITY OF THE THEORY OF WEAK INTERACTIONS. Kirzhnits, D. A. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: 426-32(Feb 1971). (In Russian).

It is shown that within the class of the most divergent high-order perturbation terms in the weak four-fermion interaction the theory of a single weakly interacting field is renormalizable. Within the same class the theory of a set of interacting fields is renormalizable if the interaction of neutral currents and transitions between the particle states are added in the primary Lagrangian. With presence of the strong interaction the parity violating meson-baryon and meson-lepton interactions are also added. In all cases the number of the additional interactions is finite. In this situation the known estimates of the upper bounds of applicability of the weak interaction theory based on the analysis of the strongest divergencies in the perturbation theory became invalid. At present status of the experiment the renormalized coupling constants for most of the introduced interactions (with exception of the $K^0 - \bar{K}^0$ transition) may be put equal to zero. This enables one to conserve the main properties of weak interactions: universality, selection rules etc., if these properties are formulated in terms of the renormalized quantities. (auth)

33664 MUON ENERGY LOSSES AND RANGE STRAGGLING IN THE $10 < E < 10^5$ GeV REGION. Bergamasco, L.; Picchi, P. (CNR, Turin. CNEN, Frascati, Italy). Nuovo Cim.; 3B: No. 1, 134-48(11 May 1971).

The energy loss rate of underrock muons of energy between 10 and 10^5 GeV is calculated using recent experimental information on the nuclear interactions and recent calculations on pair production and bremsstrahlung. The effect of the range straggling is evaluated with an accurate Monte Carlo calculation and the intensity-depth curve at great depths is derived for different values of the index of the muon energy spectrum at sea level in the TeV region. (auth)

33665 REMARKS ON THE RADIATIVE CORRECTIONS OF ORDER α^2 TO MUON DECAY AND THE DETERMINATION OF G_μ. Roos, Matts (CERN, Geneva); Sirlin, Alberto. Nucl. Phys.; B29: 296-304(1971).

Several theoretical aspects of the study of the radiative corrections to the total decay probability P in μ-decay are discussed. On the basis of the theorem on cancellation of mass singularities, and by a simple argument, that part of the radiative corrections of order α^2 to P is obtained which contains mass singularities (i.e. terms which diverge in the mathematical limit $m_e \to 0$) in an expansion in powers of the renormalized charge. A theorem on the effect of the finite electron mass on the radiative corrections of order α is also stated. An exponentiation method recently applied to study the corrections to P is discussed. It is then shown by direct calculation that the method, as presently implemented, is ambiguous and that it leads, to order α^2, to a violation of the conclusions obtained on the basis of the theorem on mass singularities. Finally what is considered to be the best value presently available for G_μ in the framework of the local V–A theory is given and the expected order of magnitude of the theoretical error is briefly discussed. (auth)

XUM

33666 MEASUREMENT OF THE FORM FACTOR $f_+(q^2)$ FROM K_{e3}^0 DECAYS. Chien, C.-Y. (Johns Hopkins Univ., Baltimore); Cox, B.; Ettlinger, L.; (and others). Phys. Lett.; 35B: No. 3, 261-4(24 May 1971).

A sample of 17,000 $K_L^0 \to \pi e \nu$ decays was measured at the Stanford Linear Accelerator Center using a wire chamber magnetic spectrometer. K_{e3}^0 decays were separated from other K_L^0 decay modes by using kinematic tests, muon identification by penetration of a Pb wall and electron identification by a shower counter array. It is found that the data in fixed q^2 bands are in reasonable agreement with the V-A theory and the unparametrized form factor $f_+(q^2)$ is presented. Using the usual linear parametrization $f_+(q^2) \sim 1 + \lambda_+ q^2/m_\pi^2$, $\lambda_+ = 0.05 \pm 0.01$ was obtained. (auth)

33667 DEUTERON DISINTEGRATION, NEUTRAL CURRENTS, AND ANTINEUTRINO SPECTRA FROM FISSION. Ahrens, Tino (Georgia Inst. of Tech., Atlanta); Lang, T. P. Phys. Rev., C; 3: 979-83(Mar 1971).

Differential and integral cross sections for the disintegration of the deuteron by antineutrinos, both in the charge-exchange and the hypothetical charge-retention mode, are presented, together with the salient features of assumptions and calculations. The incident spectra used, those due to equilibrium and instantaneous fission, are also presented. For comparison, integral cross sections weighted by the lithium-8 spectrum are added. When weighted by the equilibrium fission spectrum, the values derived of the integral cross sections in the two modes are $\sigma_{nn} = 0.272 \times 10^{-44}$ cm^2 and $\sigma_{pn} = 0.655 \times 10^{-44}$ cm^2, respectively. (auth)

Strong (General)

Refer also to abstract 33875.

33668 (INP-713(Vol.2)) PROCEEDINGS OF THE X CRACOW SCHOOL OF THEORETICAL PHYSICS. SCATTERING OF COMPOSITE OBJECTS. VOLUME II. Dalitz, H.; Gierula, J.; Karl, G.; Koba, Z.; Pniewski, J.; Rayski, J.; Ringland, G. A.; Wolter, W.; Fonda, L. (Institute of Nuclear Physics, Krakow (Poland)). Jun 1970. 163p. Dep. NTIS (U. S. Sales Only).

There were eight lectures presented for all of which separate abstracts were prepared. (J.F.P.)

For abstracts of individual lectures see: 33516, 33532, 33533, 33574, 33669, 33687, 33688, and 33849.

33669 (INP-713(Vol.2), pp 122-37) REGGE CUT PHENOMENOLOGY. Ringland, G. A. (Rutherford High Energy Lab., Chilton (England)).

A review is given of Regge cut phenomenology and includes the difficulties of pure Regge pole models, general properties of Regge cuts, the absorption model, the ambiguity of Regge pole input, dual versus nondual inputs, and problems. (J.F.P.)

33670 DIVERGENCE OF THE N-LOOP PLANAR GRAPH IN THE DUAL-RESONANCE MODEL. Kaku, Michio; Scherk, Joeel (Univ. of California, Berkeley). Phys. Rev., D; 3: 2000-4(15 Apr 1971).

Many of the results of a previous paper on the divergence of the two-loop planar graph are generalized to the multiloop case. In particular, the N-loop amplitude is shown to diverge in at least $2^N - 1$ places, though no attempt is made to show that these are the only divergences. The implication of this result to the renormalization program is discussed. (auth)

33671 RENORMALIZATION GROUP AND STRONG INTERACTIONS. Wilson, Kenneth G. (Stanford Univ., Calif. Cornell Univ., Ithaca, N. Y.). Phys. Rev., D; 3: 1818-46(15 Apr 1971).

The renormalization-group method of Gell-Mann and Low is applied to field theories of strong interactions. It is assumed that renormalization-group equations exist for strong interactions which involve one or several momentum-dependent coupling constants. The further assumption that these coupling constants approach fixed values as the momentum goes to infinity is discussed in detail. However, an alternative is suggested, namely, that these coupling constants approach a limit cycle in the limit of large momenta. Some results of this paper are: (1) The e^+-e^- annihilation experiments above 1-GeV energy may distinguish a fixed point from a limit cycle or other asymptotic behavior. (2) If electrodynamics or weak interactions become strong above some large momentum Λ, then the renormalization group can be used (in principle) to determine the renormalized coupling constants of strong interactions, except for U(3) × U(3) symmetry-breaking parameters. (3) Mass terms in the Lagrangian of strong, weak, and electromagnetic interactions must break a symmetry of the combined interactions with zero mass. (4) The $\Delta I = \frac{1}{2}$ rule in nonleptonic weak interactions can be understood assuming only that a renormalization group exists for strong interactions. (auth)

33672 THEORY OF PIONIZATION. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 3: 2195-2209(1 May 1971).

A detailed study is made of the phenomenon of pionization. First attention is given to processes in which the two incident particles are identical, e.g., proton-proton scattering. By assuming that the c.m. system has no special significance in high-energy scattering or, more precisely, by assuming that the distribution of pionization products has a forward-backward symmetry not only in the c.m. system but also in a class of coordinate systems called the C systems (this assumption will be called the symmetry hypothesis), rather precise information can be obtained about the dependence of pionization distribution on the longitudinal momenta. In particular, the one-particle distribution function is $f(p_\perp)d^3p/E$. These results are then explicitly verified in the model of quantum electrodynamics. Next, the considerations are extended to processes in which the two incident particles are different. For such processes, the limiting hypothesis is proposed: The distribution of the pionization products is independent of the momenta of either of the incident particles in the limit the incident momenta are both infinite. With this hypothesis quantitative information can be obtained on the dependence of the pionization distribution on the longitudinal momenta. When applied to the special case of identical particles, the limiting hypothesis is equivalent to the symmetry hypothesis. For the more general case where the two incident particles are not identical, it follows from the limiting hypothesis that the one-particle distribution function is again $f(p_\perp)d^3p/E$, but the results on the multiparticle distribution functions are slightly weaker than those for identical particles. The limiting hypothesis is then shown to be valid in various field-theory models. The process of photon-fermion scattering is studied in particular detail. The process of bremsstrahlung is also investigated and it is shown that it gives no pionization products. Finally, the above results are examined in the context of scalar electrodynamics, and all of the qualitative features are found to be the same. (auth)

33673 INCLUSIVE REACTIONS AND DUAL-RESONANCE MODELS. Gordon, David (National Accelerator Lab., Batavia, Ill.); Veneziano, G. Contract AT(30-1)-2098. Phys. Rev., D; 3: 2116-24(1 May 1971).

The theoretical and phenomenological advantages of looking at inclusive-type reactions in dual-resonance models are discussed. The case of single-particle distributions is considered in some detail, and part of the contributions explicitly evaluated. It is found that such contributions exhibit "scaling" behavior of the type observed long ago by Amati, Fubini, and Stanghellini in the multiperipheral model and which was reproposed in more precise terms recently by Feynman and by Benecke, Chou, Yang, and Yen. The explicit form of the limiting distribution is given. A similar behavior is found in the case of the multiparticle distribution. The need of manageable techniques for computing high-energy limits of dual loop discontinuities is stressed. Comments are made on the possible relevance of the results on deriving bootstrap-type conditions from duality and in providing a way to understand the connection between the dual-resonance model and other models of current interest. (auth)

33674 MULTIPLICITY DISTRIBUTION AND SINGLE-PARTICLE SPECTRUM IN THE DIFFRACTIVE MODEL. Hwa, Rudolph C. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Phys. Rev. Lett.; 26: 1143-7(3 May 1971).

It is first argued that in the diffractive model the multiplicity distribution should behave as n^{-2} at high n. It is then shown how this behavior can be obtained in the statistical description of the two clusters, in which the cluster multiplicity is proportional to its mass. Finally the single-particle spectrum is calculated without any free parameters except for normalization and is shown to agree remarkably well with present data that give a cross section that is constant modulo a factor ln s. (auth)

33675 HELICITY POLES, TRIPLE-REGGE BEHAVIOR, AND SINGLE-PARTICLE SPECTRA IN HIGH-ENERGY COLLISIONS. DeTar, C. E. (Massachusetts Inst. of Tech., Cambridge); Jones, C. E.; Low, F. E.; (and others). Contracts AT(30-1)-2098; NYO-2262TA-234. Phys. Rev. Lett.; 26: 675-6(15 Mar 1971).

Following Mueller, the single-particle production spectrum is related to a discontinuity in a six-line amplitude through a generalized optical theorem. Assuming only analyticity of the six-line amplitude in its angular momenta, a general expression is obtained for the behavior of the production spectrum near the phase-space boundary. To study the asymptotic limit appropriate

to this region, use is made of analytic continuation to complex helicities. (auth)

33676 NEW REGGE PHENOMENOLOGY OF INCLUSIVE REACTIONS. Chan, Hong-mo; Hsue, C. S.; Quigg, C.; Wang, Jiunn-ming (State Univ. of New York, Stony Brook). Contract AT(30-1)-3368B. Phys. Rev. Lett.; 26: 672-4(15 Mar 1971).

Inclusive reactions are studied in terms of familiar techniques of Regge phenomenology. Distributions are predicted to approach limiting behavior as $A + Bs^{-1/2}$. The constraints of duality and factorization lead to many interesting relations between different single-particle spectra, all of which can be tested at energies below 20 GeV. (auth)

33677 DUAL PARTON PICTURE. Olesen, P. (CERN, Geneva). Nucl. Phys.; B29: 77-103(1971).

A quantitative study is made of the recent speculations that the N-point Veneziano amplitude can be viewed as the limit of very high-order unrenormalized Feynman diagrams. A general statistical formalism for investigating the behavior of very high-order Feynman diagrams is developed. Within the framework of the electric-circuit analogy the concept of the mean resistance of a propagator is introduced. It is shown that the combined effect of the fluctuations around the mean resistance is smaller than one would expect. It then follows that a family of n-dimensional integrals over Feynman parameters can be evaluated in the limit $n \to \infty$. This implies that the Feynman amplitude with soft ("wee") virtual particles (partons) can be replaced by a simple Gaussian expression (with no loop integrations) to a good approximation in the limit of very high order, provided the parton Lagrangian contains a super-renormalizable ϕ^3 part. Having obtained this result, Nielsen's variational principle follows if the discrete Feynman net is replaced by a continuous distribution of propagators. The Regge slope is expressed in terms of the parton mass. (auth)

33678 DUALITY AND INCLUSIVE PHENOMENOLOGY. Ellis, J.; Finkelstein, J.; Frampton, P. H.; Jacob, M. (CERN, Geneva). Phys. Lett.; 35B: No. 3, 227-30(24 May 1971).

It is suggested that Regge corrections to an energy-independent cross section for the inclusive process $a + b \to c + X$ are expected to be absent in general only if both the channels (ab) and ($ab\bar{c}$) are exotic. Duality for two-body scattering which involves an unstable hadron is discussed. (auth)

33679 DO ABNORMAL C = +1, $J^P = 1^-$ MESON EXIST? Barshay, S. (Univ. of Copenhagen). Lett. Nuovo Cim.; 1: No. 21, 853-6(22 May 1971).

The possibility is considered that the decay configurations associated with new narrow meson states in the 950- to 1000-MeV mass region represent the decay modes of a single particle with I = 1 or two nearly degenerate particles with I = 1 and I = 0. It is assumed that these mesons have $J^P = 1^-$ and that the neutral mesons have the abnormal charge conjugation property C = +1. The possibility that C is not an invariance of hadronic electromagnetic interactions is considered. The use of this possibility in providing new mechanisms for exploring η decay and the dipole structure of the nucleon electromagnetic form factor is noted. (L.B.S.)

33680 DYNAMICAL APPLICATIONS OF THE VENEZIANO FORMULA. Mandelstam, Stanley (Univ. of California, Berkeley). pp 165-281 of Lectures on Elementary Particles and Quantum Field Theory. Vol. 1. /Deser, Stanley (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The topics discussed include considerations motivating the Veneziano formula, the Veneziano formula for the four-point and n-point scalar amplitudes, factorization, the operator formalism, Veneziano-type quark models, and higher-order Feynman-like diagrams. (J.F.P.)

33681 SCALING IN THE DUAL-RESONANCE MODEL. Chaichian, M. (Durham Univ., Eng.). Lett. Nuovo Cim.; 1: No. 20, 831-4(15 May 1971).

The Bjorken limit of a two-current dual amplitude is studied where the currents are included in the dual-resonance model according to minimal gauge interactions. It is found that to second-order in the strong-interaction coupling constant the structure function νW_2 scales, $\nu W_2 \to F_2(\omega)$, while W_1 vanishes, $W_1 \to (K^2)^{-1} F_1(\omega)$. No cutoffs were imposed; the exponential divergence appearing in the dual loop diagrams was removed by renormalization. (L.B.S.)

33682 HIGH-ENERGY SCATTERING OF A FERMION WITH ANOMALOUS MAGNETIC MOMENT: NONEXPONENTIATION. Cheng, Hung; Wu, Tai Tsun (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen-Synchrotron, Hamburg). Contract AT(30-1)-4101. Phys. Rev., D; 3: No. 10, 2394-6(15 May 1971).

Although it is well known that the scattering amplitude for a Dirac particle in a potential takes a simple-exponential form at high energies, it is shown here that this is no longer the case if the Dirac particle has an anomalous magnetic moment as in the case of the proton. This serves as an example of the conclusion that simple exponentiation holds only if a particle can be treated as a point with no internal structure or internal degrees of freedom. This means that simple exponentiation is unlikely to occur for high-energy amplitudes of hadron-hadron scattering. (auth)

33683 NEW DUAL QUARK MODELS. Bardakci, K.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., D; 3: No. 10, 2493-2506(15 May 1971).

On the basis of new representations of the projective group, some new dual quark models are constructed whose spin and internal symmetry are not multiplicative. One model is a factorized theory of exotic states with broken exchange degeneracy, ninth mesons being optional. The exotic states are suppressed three units below the Pomeranchon. In another model, with spin-orbit coupling and curved trajectories, both spin ghosts and orbital ghosts are involved in the Ward identities. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 33557, 33769, and 33856.

33684 (COO-264-572) TENSOR MESON DOMINANCE AND REGGE COUPLINGS. Freund, Peter G. O. (Chicago Univ., Ill.). Feb 1971. Contract AT(11-1)-264. 22p. (EFI-71-8). Dep. NTIS.

The helicity structure of mesonic Regge couplings is discussed in the context of meson pole dominance for the matrix elements of vector currents and of the energy momentum tensor. Experimental tests of this helicity structure are proposed. The obtained couplings are incompatible with the $U(6)_W \times O(2)_{L_z}$ symmetric quark model, and they therefore provide a guide toward $U(6)_W \times O(2)_{L_z}$ symmetry breaking. Universal couplings for higher spin ($J > 2$) mesons are considered. (auth)

33685 (DEMO-71/7) POSSIBILITY OF OBTAINING ASYMPTOTICALLY DECREASING EFIMOV AMPLITUDES. Georgalas, C. G. (Democritus Nuclear Research Center, Athens (Greece)). Mar 1971. 7p. Dep. NTIS (U. S. Sales Only).

The $\pi + \pi \to \pi + \pi$ interaction is discussed using a nonpolynomial interaction Lagrangian. The possibility of obtaining asymptotically decreasing Efimov amplitudes is considered. (J.F.P.)

33686 (DESY-71/14) MODEL FOR VECTOR-VECTOR-TENSOR MESON COUPLING CONSTANTS. Renner, B. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Mar 1971. 10p. Dep. NTIS (U. S. Sales Only).

By the joint assumptions of vector meson dominance for the electromagnetic current and tensor meson dominance for the energy-momentum tensor a model for the vector-vector-tensor meson vertex is developed, including also the coupling of two photons to a tensor meson and the coupling of one photon to the vector-tensor meson system. In its simplest possible form the model has no undetermined parameters. Tentatively the vertex is applied to compute a tensor-meson exchange contribution to vector-meson scattering from an unpolarized target, and s-channel helicity conservation is found at large energies. (auth)

33687 (INP-713(Vol.2), pp 1-5) SURVEY OF THE QUARK MODEL FOR HADRONIC STATES. Dalitz, R. H. (Oxford Univ. (England). Dept. of Theoretical Physics).

The interpretation of mesonic states in terms of the $\bar{q} - q$ model was treated, and the baryonic states were considered as qqq systems. It was concluded that a relativistic treatment is needed for the dynamics, even in the case of nonrelativistic internal motions. (J.F.P.)

33688 (INP-713(Vol.2), pp 55-84) VENEZIANO n-POINT FUNCTION SYMMETRIC REPRESENTATIONS AND THEIR IMPLICATIONS. Koba, Z. (Niels Bohr Institutet, Copenhagen (Denmark)).

The discussion of the symmetric representations of the Veneziano n-point function covers quark diagrams and resonances, construction of the n-point function, the multiperipheral configuration, the string model and operator formalism, symmetric representation, the Moebius transformation, and the fluid model (symmetric field theory) conformal invariance. (J.F.P.)

XUM

33689 (LPTHE-TH-71/11) KIND OF REALISTIC DUAL N-MESON AMPLITUDES. Mestres, L. Gonzalez (Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies). Feb 1971. 45p. Dep. NTIS (U. S. Sales Only).

An algorithm is presented allowing the construction of dual N-meson amplitudes incorporating any kind of linear trajectories. These amplitudes are of the type in which a polynomial modifies the Chan integrand. At the leading level one has neither degeneracy nor ghosts. The degeneracy is finite at any nonleading level but the problem of negative-residue ghosts on the nonleading trajectories is somehow worse than for the ordinary N-point B-functions. (auth)

33690 (NP-18823) UNITARITY CALCULATION FOR ELASTIC SCATTERING BASED ON UNCORRELATED JET MODEL WITH REGGE PHASES. Research Report No. 1/1971. Sohlo, Seppo (Jyvaskyla Univ. (Finland). Dept. of Physics). Mar 1971. 11p. Dep. NTIS (U. S. Sales Only).

Using unitarity the imaginary part of the elastic scattering amplitude for identical bosons is calculated. It is assumed that the amplitudes of the intermediate states factorize in momenta, transverse momenta are limited and the phases of one-particle amplitudes are given by the Regge model. The resulting expression is a sum of exponential functions in four-momentum transfer t with slopes growing as the multiplicity of intermediate states increases. The energy dependence is included in n-particle production cross sections multiplying the exponential t-dependent functions. (auth)

33691 (NYO-2262-TA-238) STUDY OF THE 1^+ B MESON AS A $\pi\omega$ BOUND STATE. Shen, Pu; Kang, Kyungsik (Brown Univ., Providence, R. I.). [1970]. 28p. Dep. NTIS.

A reciprocal bootstrap calculation of the $\rho(1^-)$ and $B(1^+)$ mesons in π-ω scattering is performed whereby keeping both s- and d-wave interactions at the $B_{\pi\omega}$ vertex. Following previously developed general theoretical framework which treats the pseudoscalar and vector meson systems, the N/D solution is obtained algebraically through a pole approximation to the phase space integral at energies below threshold. Given m_ρ at 765 MeV, a reasonable result was found for the set of parameters m_B, Γ_B, $g_{\pi\omega\rho}$, g_s and g_d: $m_B = 1225$ MeV, $\Gamma_B = 158$ MeV, $g_{\pi\omega\rho} = 9.25$, $g_s = 2.60$ and $g_d = -6.66$. Furthermore, the angular distribution for the B decay calculated from $g_d/g_s = -2.56$ is in good agreement with experiment. (auth)

33692 (NYO-3829-69) AXIAL VECTOR CURRENT AND PCAC IN THE σ-MODEL. Maurer, R. H.; Willey, R. S. (Pittsburgh Univ., Pa. Dept. of Physics). Apr 1971. Contract AT-(30-1)-3829. 28p. Dep. NTIS.

An explicit operator construction of the axial vector current in the boson σ-model is given in perturbation theory. This current is finite and satisfies the PCAC condition with the renormalized pion field. It also (at least formally) satisfies the $SU_2 \times SU_2$ equal-time time-component current algebra. (auth)

33693 (SU-1206-247) STRANGE PARTICLE PRODUCTION IN THE MULTIPERIPHERAL MODEL. Amann, R. F. (Syracuse Univ., N. Y. Dept. of Physics). Mar 1971. 9p. (NYO-3399-247). Dep. NTIS.

The production of particles carrying a conserved quantum number is investigated in the multiperipheral model. The Chew-Pignotti bootstrap condition is appropriately modified. The available data for strange particle production at laboratory energies are shown to have a natural explanation, within the model, if the effective κ^* intercept is equal to that of the ρ. An unexpected result is that, for precisely this value of the κ^* intercept, the ratio of κ's to π's produced rises with energy, in accordance with experimental indications. (auth)

33694 (SU-1206-248) RESTRICTIONS ON THE ANGULAR MOMENTUM OF t-CHANNEL EXCHANGES FROM s-CHANNEL HELICITY CONSERVATION. Blackmon, Maurice L.; King, Marcia J.; Wali, Kameshwar C. (Syracuse Univ., N. Y. Dept. of Physics). Mar 1971. 10p. (NYO-3399-248). Dep. NTIS.

It is shown that there are constraints on the angular momentum of t-channel exchanges due to s-channel helicity conservation in the elastic reactions of $0 + S \rightarrow 0 + S$. (auth)

33695 (UR-875-337) DIFFRACTION PRODUCTION OF BOSONS. Ferbel, T. (Rochester Univ., N. Y. Dept. of Physics and Astronomy). 29 Mar 1971. Contract AT(30-1)-875. 45p. Dep. NTIS.

Recent results obtained in the analysis of diffractively produced multimeson systems are summarized, and speculation is made on the mechanism responsible for these production processes. (auth)

33696 REGGE TRAJECTORIES IN A MULTICHANNEL QUARK MODEL. Ahmadzadeh, Akbar; Kaufmann, William B. (Arizona State Univ., Tempe). Phys. Rev., D; 3: 1923-7(15 Apr 1971).

Meson trajectories are considered in a nonrelativistic quark model. The model, in a specific example involving the ρ trajectory, incorporates a $\pi\pi$ channel and two quark-antiquark $q\bar{q}$ (or nucleon-antinucleon) channels in spin triplet states. A harmonic-oscillator potential provides the attractive $q\bar{q}$ potential, and a Yukawa potential is used in the $\pi\pi$ channel. A short-range potential of exponential type couples the $\pi\pi$ and $q\bar{q}$ channels. The model gives infinitely rising trajectories with resonances of small finite width capable of decaying into pions, but not into quarks. The ρ trajectory deviates considerably from a straight line in the negative-energy region. The model is capable of imposing exchange degeneracy in a natural way. (auth)

33697 YANG-MILLS FIELDS AND THE $\pi\pi$ INTERACTION. Basdevant, J. L.; Zinn-Justin, J. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Phys. Rev., D; 3: 1865-73 (15 Apr 1971).

Starting from a Lagrangian where the ρ meson is treated as a Yang-Mills field, $\pi\pi$ scattering amplitudes are calculated in the one-loop approximation. The summation of the strong-coupling perturbation series is performed with a unitary-rational-function approximation, and the ρ appears as a true resonance. It is shown that the interaction generates the d-wave f_0 resonance, and a very broad s-wave σ resonance. The model yields a version of the Kawarabayashi-Suzuki-Riazuddin-Fayyazuddin relation, which agrees very well with experiment, and our s-wave amplitudes are close to the current-algebra predictions. Some conclusions are drawn on $\pi\pi$ dynamics. (auth)

33698 RENORMALIZATION OF CHIRALLY INVARIANT LAGRANGIANS. Keck, B. W.; Taylor, J. G. (Univ. of Southampton, Eng.). Phys. Rev., D; 3: 1846-50(15 Apr 1971).

The renormalization problem is discussed for chirally invariant Lagrangians constructed from the pion isovector fields alone. It is found that S-matrix elements have ultraviolet divergences even after the damping from resummation has been effected. The counterterms necessary to remove such divergences are shown to modify the original current commutation relations; it is not possible that these divergences cancel amongst themselves. It is concluded that the current commutation relations are inconsistent with the Lagrangian formulation, unless they are changed or further particles are introduced. (auth)

33699 DECAY WIDTHS OF THE BOSON RESONANCES. Lee, Chien-er (Purdue Univ., Lafayette, Ind.). Phys. Rev., D; 3: 2296-7(1 May 1971).

Using the method due to Carruthers to express the decay rates of baryon resonances, formulas are derived to express the decay rates of the boson resonances with arbitrary spins which decay into a pion and a boson with spin 0, 1, or 2. (auth)

33700 VENEZIANO SECONDARY TERMS FOR $\bar{p}n \rightarrow 3\pi$. Gopal, G. P.; Migneron, R.; Rothery, A. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 3: 2262-6(1 May 1971).

The form of the four-point Veneziano amplitude suitable to describe $\bar{p}n \rightarrow 3\pi$ at rest is accurately determined. The essential parameters are found by fitting the two-dimensional surface of the Dalitz-plot distribution directly. Excellent agreement with experiment is obtained, showing secondary terms to be essential. (auth)

33701 HARD-MESON CALCULATION OF $K\pi$ SCATTERING. Pond, Paul (Northeastern Univ., Boston). Phys. Rev., D; 3: 2210-24(1 May 1971).

The hard-meson $SU(3) \times SU(3)$ current-algebra four-point functions are applied to $K\pi$ scattering, using pole dominance of the σ commutators. The S- and P-wave scattering lengths and effective ranges are extracted. The hard-meson S-wave scattering lengths differ from the soft-pion Weinberg scattering lengths by only a few percent. Energy-dependent fits up to 1 GeV and above are made. All the available experimental data on the elastic and charge-exchange cross sections and phase shifts can be fitted using the parameter F_K/F_π. (auth)

33702 STUDY OF CHIRAL SU(2) x SU(2) CURRENT-ALGEBRA MODELS. Vaughn, Michael T. (Northeastern Univ., Boston. Univ., Vienna). Phys. Rev., D; 3: 2241-9 (1 May 1971).

The smoothness assumptions of the chiral $SU(2) \times SU(2)$ hard-pion current-algebra method are examined in detail. A new model, the current-smoothness model, emerges as a plausible alternative

to the standard hard-pion model of Schnitzer and Weinberg, and others. The two models give satisfactory predictions for the decay $A_1 \rightarrow \rho + \pi$, but quite different predictions for the decay $A_1 \rightarrow \pi + \gamma$ and the colliding-beam reaction $e^+e^- \rightarrow A_1^\pm \pi^\mp$. Other possible models are also discussed. (auth)

33703 0^{+-} MESONS, EQUAL-TIME COMMUTATORS, AND SYMMETRY BREAKING. Goni, M. A. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev., D; 3: 2185-90(1 May 1971).

$0^\pm$ mesons are studied in connection with equal-time commutators and soft-meson extrapolations whereby values of interesting quantities including SU(3) × SU(3)-violating parameters are found. (auth)

33704 RESONANCES OF ARBITRARY MULTIPLICITY. Chan, Lai-him; Slansky, Richard (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 3: 2099-2108(1 May 1971).

The constraints of unitarity on an amplitude containing J degenerate resonances are solved, and several parametrizations of the solution are given. In one solution, the unitary amplitude is obtained from the narrow-width limit. Forms suitable for other theoretical applications and for phenomenology are included. The wide variety of possible cross sections and Argand diagrams for the general case are discussed, and examples of the tripole are shown. The well-known results for the dipole are rederived without effort. (auth)

33705 ORBITAL-EXCITATION MODEL FOR HADRONS. Mansouri, F. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-4076. Nuovo Cim.; 3A: 220-38(1 May 1971).

A model for hadrons is studied which identifies their internal degrees of freedom with "orbital excitations" and suggests a covariant formalism for their description. Assuming that the spin and the orbital degrees of freedom decouple in the Born approximation, it is shown how to construct wave functions, propagators and vertex functions for any meson–meson scattering process. It is found that to preserve analyticity, crossing symmetry and Regge asymptotic behavior, the orbital states must transform according to reducible representations of the group $SL_{2,c}$. The results are explicitly applied to $\pi\pi$ scattering, where it is found that the amplitude constructed along these lines has a satisfactory low-energy behavior as well. (auth)

33706 NINTH MESON WITH $J^{PC} + 1^{++}$. Rosner, Jonathan L. (Univ. of Minnesota, Minneapolis); Colglazier, E. William. Phys. Rev. Lett.; 26: 933-6(12 Apr 1971).

Expected properties of the D′ (the ninth meson with $J^{PC} = 1^{++}$) include (a) assignment to a weakly mixed SU(3) singlet, predicted by duality; (b) a mass of ~950 MeV, predicted by superconvergence; (c) decay modes $\eta\pi\pi$ and $\pi^+\pi^-\gamma$; and (d) the possibility of a suppressed ρ signal in the $\pi^+\pi^-$ spectrum of the $\pi^+\pi^-\gamma$ final state, despite the expectation that the pions are in a state with I = J = 1. These features suggest that a recently reported meson near the mass with decay modes $\eta\pi\pi$ and $\pi^+\pi^-\gamma$ may be a candidate for this state. (auth)

33707 EXOTIC RESONANCES FROM THE MULTIPERIPHERAL MODEL. Ball, James S.; Pinsky, Stephen S. (Univ. of Utah, Salt Lake City). Phys. Rev. Lett.; 26: 669-71(15 Mar 1971).

Using fundamental theorems about integral equations, it is shown that the multiperipheral model for forward pion-pion elastic scattering requires the existence of a Regge trajectory with isospin two. (auth)

33708 VENEZIANO-MODEL CALCULATIONS FOR THE DECAY $Q \rightarrow K\pi\pi$. Otter, G.; Goldsack, S. J. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 1: No. 15, 617-23(10 Apr 1971).

The predictions of a simple Veneziano model for the decay of the Q are presented, in which the E^0 appears as a daughter contribution. The predicted Dalitz-plot distribution is in qualitative agreement with experimental results. (L.B.S.)

33709 LOWER BOUNDS TO THE $\pi^0\pi^0$ SCATTERING LENGTH FROM THE UNITARITY, ANALYTICITY, AND CROSSING SYMMETRY. Common, A. K.; Wit, R. (CERN, Geneva). Nuovo Cim.; 3A: 179-94(1 May 1971).

It is shown that for $\pi^0\pi^0 - \pi^0\pi^0$ scattering a rigorous lower bound to the value of the scattering amplitude F(s, t, u) at s = 4 and t = 2 may be obtained from unitarity, analyticity and crossing symmetry. For a sufficiently small D-wave scattering length the corresponding threshold value of the forward-scattering amplitude F(4, 0, 0) must be greater than –2.30 pion Compton wavelengths, which corresponds to a scattering length –1.15. (auth)

33710 DETERMINATION OF UNSTABLE PARTICLES SCATTERING PHASE SHIFTS IN THE ONE-PHOTON EXCHANGE PROCESSES. Anisovich, V. V.; Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: 369-80(Feb 1971). (In Russian).

The expressions are given for angular distributions in reactions of the type of $\pi^-p \rightarrow \pi^+\pi^0 p$, $\gamma p \rightarrow \pi\pi p$, $\pi^+p \rightarrow \pi^+\omega p$ etc. provided the energy is high and the momentum transferred to the recoil nucleon is extremely small, so that one-photon exchange is dominant. These expressions explicitly contain the meson-meson scattering phase shifts. (auth)

33711 CHIRAL-INVARIANT PERTURBATION THEORY. Honerkamp, J.; Meetz, K. (Univ., Bonn). Phys. Rev., D; 3: 1996-8(15 Apr 1971).

Charap has found a particular system of pion coordinates leading to chiral-invariant amplitudes, if the usual Feynman rules are applied. It was shown that this system is determined by the condition $\det(g_{ik}) = 1$, where g_{ik} is the metric tensor of the pion space. In the general case the Feynman rules are modified by a counterterm that can be derived from an invariant measure in function space. The counterterm vanishes for g = 1. (auth)

33712 CLOSED-LOOP CALCULATIONS USING A CHIRAL-INVARIANT LAGRANGIAN: AN ADDENDUM. Charap, John M. (Queen Mary Coll., London). Phys. Rev., D; 3: 1998-9(15 Apr 1971).

The significance of the condition on the metric $\det g_{ij} = 1$, found in an earlier paper to lead to the elimination of the most divergent parts of the amplitudes, is explained on the basis of a paper by Salam and Strathdee. (auth)

33713 COLLINS–JOHNSON BOOTSTRAP CALCULATION OF THE J = 1 $\pi\pi$ SCATTERING AMPLITUDE. Lyth, D. H. (CERN, Geneva). Phys. Rev., D; 3: 1991-3(15 Apr 1971).

Bounds are established for certain integrals involving L(s), the left-hand cut contribution in J = 1 $\pi\pi$ scattering. A theoretical calculation of L(s) by Collins and Johnson is shown to violate the bounds seriously. The implications of this are discussed. (auth)

33714 UNIT-SPIN PROPAGATION FUNCTIONS AND FORM FACTORS. Schwinger, Julian (Harvard Univ., Cambridge, Mass.). Phys. Rev., D; 3: 1967-70(15 Apr 1971).

Source theory is used to derive a representation for the propagation function of a unit-spin meson. The asymptotic behavior for large momenta resembles that observed in electromagnetic form factors. (auth)

33715 BOOTSTRAP CALCULATIONS OF $\pi\pi$ SCATTERING USING THE MANDELSTAM ITERATION. Webber, Bryan R. (Univ. of California, Berkeley). Phys. Rev., D; 3: 1971-80(15 Apr 1971).

The results of some strip-model calculations of $\pi\pi$ scattering are presented. In these calculations, unitarity is imposed by means of the Mandelstam iteration. This procedure has the advantage that the output trajectories and residues (including their imaginary parts) may be computed above as well as below threshold; this is at present not feasible in calculations using the N/D technique. First, a bootstrap calculation of the ρ trajectory is carried out, neglecting Pomeranchuk exchange. The extra requirement of self-consistency above threshold is very strict, but a solution with satisfactory consistency between –1 and +2 GeV^2 is obtained. The scale of energy is established by giving the ρ resonance the physical mass; the self-consistent ρ width is then about 400 MeV. Various dynamical approximations are investigated, and it is shown explicitly that the pion mass is not a significant parameter of the dynamics. Finally, a bootstrap calculation of both the ρ and Pomeranchuk trajectories is presented. Except for the Pomeranchuk residue, the results show satisfactory self-consistency throughout the range –1 to +2 GeV^2. The self-consistent Pomeranchuk trajectory has an intercept $\alpha_P(0) \approx 1$ and a slope $\alpha_P'(0) \approx 0.5\ GeV^{-2}$. The inclusion of Pomeranchuk exchange increases the slope of the ρ trajectory, but the effect of this on the ρ resonance width is offset by a more rapid increase in the imaginary part of the trajectory, and the self-consistent ρ width is now about 600 MeV. In contrast to the more encouraging consequences of including Pomeranchuk exchange in recent N/D calculations, these results suggest that the physical ρ is in fact primarily a bound state of some channel other than $\pi\pi$. (auth)

33716 DUAL-RESONANCE MODEL WITH QUARK SPIN. Yoshimura, Motohiko (Univ. of Chicago). Phys. Rev., D; 3: 1945-53(15 Apr 1971).

A dual-resonance model with nontrivial quark spin factors is presented. An amplitude is found which satisfies factorization and eliminates the parity-doubling ghosts. An application to $\pi\pi$ elastic scattering indicates that the positivity condition is not met on the

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first daughter trajectory if one assumes realistic values for the mass and intercept. (auth)

33717 STRESS-TENSOR–CURRENT COMMUTATION RELATIONS, THE PION-MASS FORM FACTORS, AND TENSOR- AND SCALAR-MESON DOMINANCE. Raman, K. (Wesleyan Univ., Middletown, Conn.). Phys. Rev. Lett.; 26: 1069-72(26 Apr 1971).

The low-energy behavior of the pion-mass form factors is derived using stress-tensor–current commutation relations. The results indicate significant deviations from tensor-meson and scalar-meson pole dominance of the stress tensor. The stress-tensor–ϵ-meson coupling and the scale dimension of the pion field are obtained in terms of $g_{A_1\epsilon\pi}$. Numerical estimates are given. (auth)

33718 QUANTUM NUMBERS OF NONSTRANGE, NEUTRAL BOSONS. Sugawara, Masao (Purdue Univ., Lafayette, Ind.). Phys. Rev. Lett.; 26: 1067-9(26 Apr 1971).

It is shown that the trilinear (or Yukawa-type) vertex of a nonstrange, neutral boson with a spin-$\frac{1}{2}$ baryon vanishes unless the boson has the quantum numbers of the quark-antiquark ($q\bar{q}$) system, as long as this vertex satisfies the usual analyticity conditions and C and P are good quantum numbers. Thus, the quantum numbers of the observed nonstrange bosons may be explained without the quark. (auth)

33719 DOUBLE PARTICLE EXCHANGE IN HADRONIC REACTIONS. Harari, Haim (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: 1079-83(26 Apr 1971).

It is shown that, contrary to present practice and belief, double-particle-exchange contributions to hadronic scattering amplitudes are not negligible. A hierarchy of exchange mechanisms are introduced: (i) Pomeranchon, (ii) single pole exchange (including pole-Pomeranchon cuts), (iii) double particle exchange, etc. The relative strength of any pair of consecutive terms in this hierarchy of amplitudes is of order $\eta = \eta_0 \nu^{-\frac{1}{2}}$, where $\eta_0 \sim 0.6$ BeV$^{\frac{1}{2}}$. At ν = 5 BeV, double-particle-exchange amplitudes may contribute to 25–50% of the cross section for inelastic processes and should not be ignored. (auth)

33720 ZEROS AND SPECTRUM OF INFINITELY SUPERCONVERGENT AMPLITUDES. Bassetto, A. (CERN, Geneva). Lett. Nuovo Cim.; 1: No. 18, 747-52(1 May 1971).

A class of meromorphic superconvergent amplitudes is studied with given patterns of real zeros and a reasonable spectrum of intermediate states. The connection between real zeros and resonances in a class of amplitudes having the Veneziano formula is examined, taking the elastic pion–pion amplitude with isospin in the u-channel $I_u = 2$ as an example. The conclusions are assumed to hold for a general invariant amplitude with crossing symmetry between the s and t channels and exotic quantum numbers in the u one. (L.B.S.)

33721 HIGH-ENERGY BEHAVIOR OF A SPIN–FLIP AMPLITUDE. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen-Synchrotron, Hamburg); Wu, Tai Tsun. Contract AT(30-1)-4101. Phys. Rev., D; 3: No. 10, 2377-93 (15 May 1971).

The perturbation series for the spin-flip amplitude, where two units of spin are exchanged, of the scattering of two vector mesons through fermion–fermion–vector-meson coupling is studied in the limit of high energies. Similar to the case of elastic scattering (without spin flip) in quantum electrodynamics, there are, for this spin-flip amplitude, terms in the perturbation series of the orders of magnitudes s, s ln s, s(ln s)^2, s(ln s)^3, etc. For each n, the leading term in the coefficient of s(ln s)^n is due to Feynman diagrams with n + 2 closed fermion loops. These leading terms are found explicitly for the exactly forward direction, and are then summed. Because these terms alternate in sign, at high energies this sum is smaller than any one of the leading terms in the series. This sum is studied in detail for the case where massless photons are exchanged, and is found to have a simple factorization property. Some of the results are extended to the more general case of exchange massive neutral vector mesons. The high-energy behavior of this spin-flip amplitude is qualitatively different from that of the spin-nonflip amplitude studied previously. (auth)

33722 CHIRAL LOOPS. Gerstein, Ira S. (Massachusetts Inst. of Tech., Cambridge); Jackiw, Roman; Lee, Benjamin W.; Weinberg, Steven. Contracts AT(30-1)-2098; AT(30-1)3668B. Phys. Rev., D; 3: No. 10, 2486-92(15 May 1971).

The correct Feynman rules for chiral-invariant theories differ from the naive rules. The difference is such that the soft-pion theorems, including the vanishing of the pion mass, are preserved to each order of perturbation theory. In particular, there are special definitions of the pion field for which all higher-order corrections to the off-shell pion-pion scattering amplitude cancel at low momenta. (auth)

33723 DISPERSION OF THE VENEZIANO REPRESENTATION IN TRAJECTORY PARAMETERS, REGGE CUTS, AND UNITARITY CORRECTIONS. Vasavada, Kashyap V. (Purdue Univ., Indianapolis). Phys. Rev., D; 3: No. 10, 2442-7(15 May 1971).

It is suggested that the high-energy unitarity condition and Regge cuts can be built into the Veneziano model by dispersing the representation in trajectory parameters. In particular, a model of the Amati-Fubini-Stanghellini type and the optical model are considered in order to obtain the spectral functions of the integral representations. (auth)

33724 NEW QUANTUM ELECTRODYNAMICS FOR VECTOR MESONS. Tucker, R. H.; Hammer, C. L. (Ames Lab., Iowa). Phys. Rev., D; 3: No. 10, 2448-60(15 May 1971).

A quantum electrodynamics for vector mesons with arbitrary magnetic dipole and electric quadrupole moments is constructed in which the vector meson is described by a six-component column matrix satisfying a single equation of motion with no auxiliary condition. To avoid an interaction Hamiltonian which has an infinite number of surface terms, the S matrix is derived directly from Green-function solutions of the equations of motion. In the reduction of the S matrix, terms appear which do not correspond to Feynman-type terms but which vanish if only regularized integrals are used. The Feynman rules are then identical in form to the rules for scalar electrodynamics. A distinct calculational advantage of this theory is that all components of the Fock-space operators are treated on an equal footing and create and destroy particles in definite energy and helicity states. Trace theorems for the covariantly defined spin-1 matrices are given to further facilitate calculations. The same techniques are applied to the electrodynamics of arbitrary-spin particles. A discussion of the renormalization is given: All of the theories are found to be non-renormalizable. (auth)

33725 HELICITY CONSERVATION AND THE $A_1\rho\pi$ COUPLING. Mueller, H. J. W. (Univ., Munich). Lett. Nuovo Cim.; 1: No. 20, 814-16(15 May 1971).

It is pointed out that the confirmation of t-channel helicity conservation in A_1 production supports the view that the A_1 decays to $\rho\pi$ predominantly via the D-wave coupling and that consequently the ρ-mesons are predominantly longitudinally polarized. (L.B.S.)

33726 NOTE ON REGGE TRAJECTORIES AND K^+ PHOTOPRODUCTION. Minami, S. (Osaka Univ.). Lett. Nuovo Cim.; 1: No. 21, 869-72(22 May 1971).

Exchange degenerate partners for the $K_\alpha(1240)$ and $K_\beta(1320)$ trajectories are examined for the reaction $\pi^+K^+ \rightleftharpoons \rho^+K^{*-}(892)$. Two models are considered, which show the exchange-degenerate $K-K_\alpha$ trajectory and an additional $\bar{K}$ trajectory as the exchange-degenerate partner of K_β. The description of K^+ photoproduction with a Regge-pole model involving conspiring trajectories is examined in light of the existence of the $\bar{K}$ trajectory suggested by duality. Some general considerations about meson trajectories are presented. (L.B.S.)

33727 NOTE ON THE ALGEBRAIC REALIZATIONS. Marculescu, S. (Univ., Bucharest). Lett. Nuovo Cim.; 1: No. 21, 873-5(22 May 1971).

Weinberg's algebraic relation for the invariant amplitude of the decay $\alpha \rightarrow \beta + \pi_i$ with massless pions is obtained for processes with two pions, using the infinite-momentum limit. (L.B.S.)

33728 CONSEQUENCES OF A FIELD-SOURCE IDENTITY IN A SPIN-TWO MESON THEORY. Raman, K. (Brown Univ., Providence). J. Math. Phys. (N. Y.); 12: No. 4, 682-8(Apr 1971).

The restrictions imposed on a spin-2 meson theory when the source is related to the stress tensor are discussed. A spin-2 meson theory with a field-source identity is considered which postulates that the traceless part of the stress tensor is proportional to the irreducible part of the spin-2 meson field. The consequences of imposing the field-source identity and Lorentz covariance on the spin-2 meson theory are examined. It is shown that the field-source identity determines the parts of the singular terms in the stress–tensor equal-time commutation relations which are the most singular in the coupling strength g. It further requires that some of the singular terms be q-numbers. The constraints imposed on the field-dependence of the source $J_{\mu\nu}(x)$ by the field-source identity and the Lorentz covariance conditions are obtained. It is shown that as a consequence of some of these, the interaction term $gJ_{\mu\nu}(x)$ must be nonlinear in the coupling strength g. (auth)

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Strong (Baryon No. = 1)

Refer also to abstracts 33558, 33563, 33572, and 33874.

33729 (INR-P-1228) LOW, INTERMEDIATE, AND HIGH ENERGIES IN THE VENEZIANO MODEL FOR THE KN SCATTERING. Namyslowski, J.; Rek, Z.; Swiecki, M. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 28p. Dep. NTIS (U. S. Sales Only).

The low-energy constraints—consistency of two Adler–Weisberger sum rules, the Adler requirement, and the isospin zero KN scattering length equal zero—are built in the Veneziano type model, with no unobserved parity doublets of particles with spin $\leq 3/2$, and no unobserved daughters of $Y(3/2^+, 1382)$. Predictions of the amplitude are checked with the experimental data for the elastic widths of resonances, differential cross sections of the charge exchange process $K^+n \to K^0p$, and the elastic backward K^+p scattering, at energies ranging from 1 up to 12.3 GeV. A reasonable qualitative agreement is found at all energies. The stability of the results and the role of the PCAC condition are discussed. (auth)

33730 (INR-P-1239) ON THE CALCULATION OF D_Λ IN THE PHASE-SHIFT APPROXIMATION. Borodziuk, S.; Dabrowski, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 12p. Dep. NTIS (U. S. Sales Only).

The accuracy of the phase-shift approximation in calculating the well-depth of a Λ-particle in nuclear matter D_Λ is investigated. A model case of a simple ΛN potential is considered. The value of D_Λ calculated in the phase-shift approximation is about 10 MeV bigger than the value obtained by the complete K-matrix method. This indicates that the phase-shift approximation is too rough for an application in the D_Λ problem. (auth)

33731 (SU-1206-244) SOME QUARK-PARTON MODEL INEQUALITIES FOR THE NEUTRON AND PROTON INELASTIC STRUCTURE FUNCTIONS. Majumdar, D. P. (Syracuse Univ., N. Y. Dept. of Physics). Feb 1971. 14p. (NYO-3399-244). Dep. NTIS.

Several inequalities are summarized for neutron and proton inelastic structure function $W_2(\nu, Q^2)$ that must be satisfied if the partons are identified with quarks. Some of these inequalities provide very useful constraint equations for the P(N) function of the parton model. Due to lack of sufficient data it is not certain at present if all the inequalities are satisfied. The importance of these inequalities lies in the fact that if any of these are confirmed not to satisfy the experimental data, the concept of individual quark-parton association has to be abandoned. (auth)

33732 REACTION $K^-p \to \bar{K}^0\pi^+\pi^-n$ AND THE GENERALIZED VENEZIANO MODEL. Gislen, L. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Lett. Nuovo Cim.; 1: No. 15, 637-42(10 Apr 1971).

The problem of half-integer spins in the application of Veneziano models to interactions of the type $KN \to KN' + n\pi$ is considered. In order to avoid this problem, the pion exchange is treated by the Reggeized OPE model and the rest of the amplitude is treated by the generalized Veneziano amplitude. This approach is applied to the $K^-p \to \bar{K}^0\pi^+\pi^-n$ interaction, and the results are found to be in good agreement with experimental data. (L.B.S.)

33733 REACTION $\pi^+p \to \eta^0\Delta^{++}$: A TEST OF A_2 REGGE-POLE EXCHANGE. Grether, D. F.; Gidal, G. (Univ. of California, Berkeley). Phys. Rev. Lett.; 26: 792-5(29 Mar 1971).

New results are presented on the reaction $\pi^+p \to \eta^0\Delta^{++}$ between 1.2 and 2.67 GeV/c. The data above 2 GeV/c, when combined with some existing data, give evidence for a dip in the t distribution near $t = -1.5$ $(GeV/c)^2$. This dip, and other features of the data, are adequately described by an A_2 Regge-pole model. The effective A_2 trajectory is calculated and found to disagree with that obtained from the reaction $\pi^-p \to \eta^0n$. (auth)

33734 K^--p BACKWARD SCATTERING. Saxena, A. B.; Singh, C. P.; Agarwal, B. K. (Allahabad Univ., India). Lett. Nuovo Cim.; 1: No. 15, 643-4(10 Apr 1971).

A two-step process $K^-p \to K^{*0}n \to K^-p$ is assumed to fit the elastic K^- + p backward scattering data, which gives the lowest t-channel two-particle exchange singularity. The process is estimated by evaluating the two-pion exchange box diagram. (L.B.S.)

33735 EXTRACTION OF ΛK^-p AND ΣK^-p COUPLING CONSTANTS FROM $K^\pm$–p FORWARD AMPLITUDES. Chao, Yung-an (Univ. of Copenhagen); Pietarinen, Esko. Phys. Rev. Lett.; 26: 1060-3(26 Apr 1971).

The difficulty about the unphysical part of the cut of $K^\pm$–p forward amplitudes is avoided by conformally mapping the unphysical and low-energy K^-–p regions on the cut onto the boundary of an ellipse and the whole cut plane to the inside of the ellipse. A discrepancy function constructed on the physical region using experimental information on the $K^\pm$–p forward amplitudes is stably extrapolated to estimate $(g_{A^2} + 0.8g_{\Gamma^2})/4\pi$ as 14^{+3}_{-2}. The signs of the real part of K^-–p forward amplitudes at high energies are found to be positive. (auth)

33736 INTERPRETATION OF THE REACTION $K_L^0p \to K_S^0p$. Johnson, W. B.; Leith, D. W. G. S.; Loos, J. S.; (and others) (Stanford Univ., Calif.). Phys. Rev. Lett.; 26: 1053-7(26 Apr 1971).

Recent data on $K_L^0p \to K_S^0p$ are interpreted in terms of two distinctly different Regge models, both of which provide good descriptions of the data. The forward differential cross sections for $K_L^0p \to K_S^0p$ and $\pi^-p \to \pi^-p \to \pi^0n$ are used to determine the f/d ratio for the nonflip coupling of vector mesons to baryons. (auth)

33737 IMPLICATION OF s-CHANNEL HELICITY PROPERTIES ON REGGE POLES. Hite, G. E. (Univ., Karlsruhe, Ger.). Lett. Nuovo Cim.; 1: No. 14, 579-83(3 Apr 1971).

It is assumed that contributions associated with the P, f^0, ω, ρ, and A_2 have s-channel helicity-flip properties. It is shown that within present Regge-pole absorption models these properties imply relations between the residue functions of each Regge pole, and that these relations will ensure the same helicity properties for contributions to all reactions involving the same vertex. The NN vertex in meson–nucleon scattering is discussed. (L.B.S.)

33738 POMERON EXCHANGE, THE S-CHANNEL SPIN-NONFLIP AMPLITUDE AND THE EXISTENCE OF THE Z*. Karasuno, T.; Minami, S. (Osaka City Univ.). Lett. Nuovo Cim.; 1: 711-15(24 Apr 1971).

A proposal is made that there is no s-channel spin-flip amplitude in the pomeron-exchange term. Also a method is suggested to examine this proposal. It is shown that this proposal is consistent with the phase-shift analysis of meson–nucleon scattering. The $\pi + N$ and $K + N$ interactions are studied. The method allows the ambiguity for the phase-shift analysis to be resolved, and the existence of the Z* to be examined in $K^+ + p$ interactions. (J.F.P.)

33739 ESTIMATE OF THE RADIATIVE DECAY WIDTH OF THE $P_{11}(1470)$. Mickens, R. E. (Fisk Univ., Nashville). Lett. Nuovo Cim.; 1: 707-8(24 Apr 1971).

The Chou–Yang model is used to obtain an estimate of the M1 transition moment of the P_{11} (1400) resonance. The decay width for $N(1400) \to p + \gamma$ is then calculated and found to be 162 keV, giving a branching ratio of 0.06% for this decay. (J.F.P.)

33740 SEMITHEORETICAL MASS FORMULA. Wellner, Marcel (Syracuse Univ., N. Y.). Phys. Rev., D; 3: 2295(1 May 1971).

The unusually accurate mass relation $N^{-1} + \Xi^{-1} + \Sigma^{-1} = 6(N + \Xi)^{-1}$ is strongly suggested by a previously described, and now extended, field theory. (auth)

33741 EXOTIC EXCHANGES AND SERPUKHOV CROSS SECTIONS. Arnold, Richard C. (Argonne National Lab., Ill.). Phys. Rev., D; 3: 2250-6(1 May 1971).

A high-lying exotic trajectory X, coupled singly to nucleons and in pairs to pions and kaons, is proposed to explain the energy dependence of total and differential cross sections in the 60-GeV region while retaining a fixed-pole Pomeranchukon. Loop diagrams (cuts) including X's are suggested as the agents reconciling pole duality (and exchange degeneracy) with experimental data on line-reversed pairs of two-body reaction cross sections and on polarizations which would vanish at high energies in the hybrid model with exchange degeneracy. A characteristic prediction of the proposed scheme is the presence of antishrinkage between 25 and 65 GeV in pion-nucleon elastic scattering near the forward direction. (auth)

33742 CONSPIRACY VERSUS REGGE CUTS IN π^-p CHARGE EXCHANGE. Hanson, Ronald W. (Arizona State Univ., Tempe). Phys. Rev., D; 3: 2225-7(1 May 1971).

A phenomenological study of π^-p charge-exchange differential cross section and polarization is made using the ρ plus a conspiring ρ′ and using the ρ plus an absorptive cut. In both cases the Regge residues are taken to have the Veneziano form $\text{const}/\Gamma(\alpha)$. The conspiracy model is found to agree with the data considerably better than the cut model. (auth)

33743 UNIQUENESS OF THE INTERACTION INVOLVING SPIN-$3/2$ PARTICLES. Nath, L. M.; Etemadi, B.; Kimel, J. D. (Florida State Univ., Tallahassee). Phys. Rev., D; 3: 2153-61 (1 May 1971).

The free-field Lagrangian as well as the propagator for spin-$3/2$ particles contains an arbitrary parameter A. However, the S-

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matrix elements for the interaction of a spin-$\frac{3}{2}$ field with other fields are always independent of this parameter, provided the interaction Lagrangian is properly chosen. For a system of a spin-$\frac{3}{2}$ field coupled to a nucleon field and a pion field, a two-parameter (A,Z) interaction Lagrangian is introduced in such a way that it is invariant under a point transformation of the spin-$\frac{3}{2}$ field. The transition amplitude for such an interaction is independent of the parameter A. However, it does depend on the second parameter Z. By requiring the interaction to be consistent with the principles of second quantization, the value of the second parameter has been fixed. Therefore, the $\Delta(1238)$ contribution to the elastic πN scattering amplitudes can be uniquely determined. Using this model for the evaluation of the $\Delta(1238)$ contribution and the chiral-invariant Lagrangians for the calculation of the nucleon pole and ρ-pole contributions, the πN scattering lengths were computed and compared with the experimental data. The calculated results are in good agreement with experiment. (auth)

33744 K^+-NUCLEON SCATTERING IN BROKEN SU(3) x SU(3). Koeberle, R.; Warszawski, J. (Univ., Sao Paulo, Brazil). Phys. Rev., D; 3: 2161-5(1 May 1971).

S-wave K^+-nucleon scattering is discussed in the framework of chiral SU(3) × SU(3), broken by a term transforming according to the $(3^*,3) + (3,3^*)$ representation, giving the usual partial conservation laws (partial conservation of vector current and partial conservation of axial-vector current). The scattering lengths are calculated for models giving the correct baryon spectrum and assuming that φ decouples from nucleons. Good agreement with experiment is obtained, supporting the breaking mechanism assumed. The numbers are $a(K^+p) = -0.27\ \mu_\pi^{-1}$ and $a(K^+n) = -0.14\ \mu_\pi^{-1}$. (auth)

33745 REGGE CUTS AND SUM RULES FOR MESON–NUCLEON CHARGE-EXCHANGE SCATTERING. Chylek, Petr (Indiana Univ., Bloomington). Phys. Rev., D; 3: 2109-11(1 May 1971).

Pseudoscalar-meson-nucleon charge-exchange scattering is investigated in the Regge pole-cut model. Using a complex-conjugate-poles approximation, several sum rules for experimentally observable quantities are derived and compared with experimental results. It is emphasized that the measurement of the polarization in the K-nucleon charge-exchange scattering can decide whether the cuts are important in charge-exchange reactions, and which cut model provides the better description of these processes. (auth)

33746 WHAT CAUSES THE DIPS IN BACKWARD PION–NUCLEON SCATTERING? Hayot, F. (State Univ. of New York, Stony Brook); Kayser, B. Contract AT(30-1)-3668B. Nuovo Cim.; 3A: 45-52(1 May 1971).

Using a Regge pole and absorptive cut model with N_α and Δ_δ exchange, it is found very difficult to explain the dip structure in pion–nucleon backward scattering in terms of wrong-signature nonsense zeros. (auth)

33747 NONLINEAR HADRON COUPLINGS FROM DIVERGENCE CONDITIONS. II. ρ MESONS, PIONS, AND NUCLEONS. Gupta, Suraj N.; Weihofen, William H. (Wayne State Univ., Detroit). Phys. Rev., D; 3: 1957-62(15 Apr 1971).

The interaction of the ρ field with pions and nucleons is investigated by extending an earlier treatment of the pion–nucleon system and imposing the requirement that the source function in the ρ-field equation have a vanishing divergence. This leads to a nonlinear equation for the ρ field without the use of either a broken symmetry or a correspondence between the neutral ρ field and the photon field. It is possible to develop our formalism with as well as without the axial-vector a field. However, the usual condition of partial conservation of axial-vector current (PCAC) is fulfilled only if the ρ field is accompanied by the a field, while a modified PCAC condition is found to hold in the absence of the a field. (auth)

33748 SIDEWISE DISPERSION RELATIONS FOR SCALAR DENSITIES. Segre, Gino (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 3: 1954-6 (15 Apr 1971).

It is shown how to calculate by sidewise dispersion relations the matrix element between nucleon states of u_i, the scalar density belonging to the $(3,\bar{3}) + (\bar{3},3)$ representation of SU(3) × SU(3). In particular a vanishing nucleon matrix element is found for the combination $u_0 - \sqrt{2}u_8$ in the limit of the pion mass approaching zero. (auth)

33749 S-MATRIX CALCULATIONS OF THE PION–NUCLEON P-WAVE SCATTERING LENGTH a_{13} BY THE N/D METHOD. Sachl, V. F. (Univ. of Durham, Eng. Inst. of Physics, Prague). Phys. Rev., D; 3: 2065-8(1 May 1971).

The S-matrix calculations for the P-wave scattering process of pions on nucleons are carried out with the help of the N/D method. According to the Balázs method the numerator function N is considered in the three-pole effective-range approximation. One of the poles in the nucleon pole, where the residue is known, is chosen. The remaining two residues (b_i, i = 1, 2) are to be calculated. The following input values are used: the ρ-meson and pion-nucleon (3,3) isobar N* discontinuities and the high-energy contributions in the crossed channels, and the nucleon pole in the direct channel. The matching procedure is the usual one: The right-hand side of one of the determining equations for the effective-range parameters b_i is analytically established by the projections of the invariant amplitudes with the aid of the fixed-s dispersion relations in a regular point S_R in the unphysical region. Then the complete determining equations are obtained by comparing these projections and their derivatives, respectively, in the matching point S_R. Having thus determined the parameters b_i and the effective-range N/D amplitude of the state $J = \frac{3}{2}$, $I = \frac{1}{2}$, the scattering length a_{13} is computed on the basis of the noncorrelated physical parameters (g^2, m, W_R^{33}, μ). Its magnitude $a_{13} = -0.019$ is in excellent agreement with the experimental value of Barnes et al. (auth)

33750 ON POSSIBILITY OF THE MESON–MESON SCATTERING PHASE SHIFT DETERMINATION IN PROCESSES WITH THE REGGE POLE EXCHANGE. Anisovich, V. V.; Shekhter, V. M. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: 651-8(Mar 1971). (In Russian).

Exchange of Regge poles and cuts is considered for reactions of the type of K + p → K + π + p (exchange of states with vacuum quantum numbers) and π+ p → π + π + N (exchange of nonvacuum trajectories). Angular distributions for these reactions are expressed in terms of reggeon parameters and meson-meson scattering phase shifts. (auth)

33751 DIFFRACTIVE-RESONANCE INTERFERENCE MODEL AND ITS APPLICATION TO K^-p SCATTERING. Lasinski, T. A. (Univ. of Chicago). Nucl. Phys.; B29: 125-59(1971).

A diffraction-resonance interference (DIM) model is shown to reproduce qualitatively the K^-p elastic, polarization, and charge exchange data from ≈0.8 to 2.6 GeV/c over the entire angular interval. Since the phenomenological diffraction background is highly suggestive of a Pomeranchukon behavior, it is felt that this model presents further evidence in support of the Harari–Freund conjecture. In the spirit of this conjecture, inadequacies of DIM in the description of data in regions localized in momentum are interpreted as evidence for the existence of as yet unresolved resonant states. (auth)

33752 PREDICTION OF S-WAVE PION–NUCLEON SCATTERING. II. Hamilton, J. (NORDITA, Copenhagen. CERN, Geneva); Petersen, J. Lyng. Nucl. Phys.; B29: 51-66(1971).

The mass-extrapolation technique is extended to predict the S-wave πN amplitudes $f_\delta^{(\xi)}(s)$ in the low- and medium-energy region. The strong short-range repulsion in the (+) charge case is also predicted. (auth)

33753 PREDICTION OF S-WAVE PION–NUCLEON SCATTERING. I. Hamilton, J. (NORDITA, Copenhagen. CERN, Geneva); Petersen, J. Lyng. Nucl. Phys.; B29: 29-50(1971).

A mass-extrapolation technique is proposed which makes it possible to predict the S-wave πN amplitude $f_0^{(+)}(s)$ satisfactorily in the interval between the physical threshold $s = (M + \mu)^2$ and the crossed physical threshold $s = (M - \mu)^2$. (auth)

33754 PHASE AND t-STRUCTURE OF EXCHANGE AMPLITUDES. APPLICATION TO $0^-\frac{1}{2}^+ \to 0^-\frac{1}{2}^+$, $0^-\frac{3}{2}^+$ REACTIONS. Shtokhamer, R.; Berlad, G.; Eilam, G. (Technion-Israel Inst. of Tech., Haifa). Nucl. Phys.; B29: 1-15(1971).

Assuming asymptotic power-law behavior in energy for exchange amplitudes their phase is determined, using analyticity and crossing. The absence of exotic resonances is applied to fix the relations between even and odd amplitudes. Two qualitatively equivalent models are presented. The first one is based on simplicity and is found to resemble some Regge-pole-model interpretations. The second one results from a surface picture for exchange amplitudes. Within the general frame discussed, the predictions of Regge-pole and absorption models become very similar. A qualitative explanation for differential cross sections in $0^-\frac{1}{2}^+ \to 0^-\frac{1}{2}^+$, $0^-\frac{3}{2}^+$ exchange reactions and for polarizations in elastic $0^-\frac{1}{2}^+ \to 0^-\frac{1}{2}^+$ processes is offered for $|t| \lesssim 2.0$ (GeV/c)^2. Differences between Harari's recent approach and ours are discussed. (auth)

33755 AFST MODEL WITH ππ AND πp PHASE SHIFTS AND DUERR–PILKUHN FORM FACTORS APPLIED TO THE REACTION $\pi^+p \to p3\pi^+2\pi^-$ AT 8 GeV/c. Jurewicz, A. (Inst. of Nuclear Research, Warsaw); Michejda, L.; Namyslowski, J.; Turnau, J. Nucl. Phys.; B29: 269-95(1971).

The double OPE (one-pion-exchange) model was applied to the reaction $\pi^+p \to p3\pi^+2\pi^-$ at 8 GeV/c. To describe $\pi\pi$ and πp vertices presently available $\pi\pi$ and πp phase shifts, and off-shell corrections according to the method of Dürr and Pilkuhn were used. Spin of proton, isospins, Bose symmetrization of pions and interference between various possible graphs were fully taken into account. Results, calculated with parameters used previously for single OPE graph by Wolf, are in fair agreement with the data. Protons are emitted too much in the backward direction due to the lack of the neglected baryon-exchange contribution. Production of resonances ρ^0 and Δ^{++} is well reproduced by the model. Interference terms contribute 48% of the cross section and increase the number of pion pairs of the same charge emitted with small opening angles. The helicity non-flip overlap function has the slope 2.7 GeV^{-2} which is to be compared with the value 10 GeV^{-2} deduced from the analysis of the π^+p elastic scattering for the sum of all inelastic channels. This would mean that the interaction radius for the six-body channel is two times smaller than the interaction radius for the main bulk of inelastic processes at this energy. (auth)

33756 RECOIL EFFECTS DUE TO MASS DIFFERENCES AND THE QUARK MODEL OF DIFFRACTIVE PRODUCTION OF N*(1470, 1690). Le Yaouanc, A.; Oliver, L.; Pene, O.; Raynal, J. C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys.; B29: 204-18(1971).

Using the scalar quark-quark amplitudes and the radii of the hadrons, fitted from elastic scattering, an attempt is made to describe without any new parameter the production of $N_{\frac{1}{2}}^{*+}$ (1470, 1690) by π or p on protons. It is shown that owing to the big mass differences the Glauber model must be abandoned and that, contrary to an earlier partial study by Hendry and Trefil, single scattering dominates near forward production and peaks at $|t| \approx 0$ with a slope smaller than the elastic one. A modification of the quark-quark amplitudes due to the mass difference $N^{*+} - p$ is also proposed. Quantitative agreement is obtained for the $N^{*+}(1690)$ up to large $|t|$. On the contrary, the forward spike of the $N^{*+}(1470)$ is not explained, although there is agreement with some data at $0.1 < |t| < 0.5$. (auth)

33757 EXCHANGE DEGENERACY TESTS IN THE RESONANCE REGION OF THE REACTIONS $\bar{K}N \to \pi\Sigma$ AND $\bar{K}N \to \pi\Lambda$. Schmid, C.; Storrow, J. K. (CERN, Geneva). Nucl. Phys.; B29: 219-29 (1971).

Duality diagrams imply that the Y* resonances in $\bar{K}N \to \pi\Sigma$, $\bar{K}N \to \pi\Lambda$ cancel on the average in the imaginary parts at fixed t. This cancellation of the Y*'s is tested in the positive t-region (at $t = m_{Y^*}^2$) using the experimental Y* couplings. The predictions of duality diagrams qualitatively verified in the resonance region are found (auth)

33758 ELECTROMAGNETIC CORRECTIONS TO THE COHERENT $K_L - K_S$ REGENERATION AMPLITUDE IN HYDROGEN. Sarma, K. V. L.; Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys.; B29: 230-6(1971).

Electromagnetic corrections to the coherent $K_L - K_S$ regeneration amplitude from protons, $f_{21} = f(0) - \bar{f}(0)$, are estimated in a model based on elastic unitarity and Regge behavior. The correction to Im f_{21}/k is found to vanish asymptotically as $(\ln s)^{-2}$. The correction to Re f_{21}/k, assuming additivity of the Coulomb- and strong-phase shifts, is also finite. Numerical values are given at a typical energy. (auth)

33759 REMOVAL OF BARYON PARITY DOUBLETS IN THE VENEZIANO MODEL FOR MESON BARYON SCATTERING. Adjei, S. A.; Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 3: No. 10, 2425-7(15 May 1971).

A technique for the removal of baryon parity doublets from the Veneziano model is developed. In this approach only even-parity (odd-parity) daughters exist for even-parity (odd-parity) parent trajectories. (auth)

33760 BARYON CURRENTS IN THE FERMI–YANG MODEL. Vasholz, David P. (Univ. of Arizona, Tucson). Phys. Rev., D; 3: No. 10, 2428-32(15 May 1971).

All possible baryon currents consisting of trilinear local products of anticommuting nucleon fields are constructed and classified with respect to SU(2) ⊗ SU(2). In contrast to the quark-model baryon currents investigated by Hwa and Nuyts, the Fermi-Yang model (nucleon field) baryon currents may be isospin $\frac{3}{2}$ as well as $\frac{1}{2}$. Commutators of the baryon currents with axial charges are investigated, as well as anticommutators of baryon currents with the Hermitian conjugates of their own divergences. Although isospin mixing does occur for some of the axial-charge–baryon-current commutators, it is found that those terms in the commutators carrying the appropriate isospin are always proportional to the baryon current being commuted. For an isospin-$\frac{1}{2}$ baryon current $B^\mu(x)$, it is found that $\delta(x_0 - y_0)\{B^\mu(x), \partial^\nu B_\nu^\dagger(y)\} = \delta(x-y)\,O(\mu,x) +$ (Schwinger term), where $\langle 0|O(\mu,x)|0\rangle = 0$. This property of $O(\mu,x)$ is equivalent to a spectral-function sum rule, the single-particle approximation of which relates the positive- and negative-parity spin-$\frac{1}{2}$, isospin-$\frac{1}{2}$ nucleon resonances. (auth)

33761 RENORMALIZABILITY OF MASSIVE SPIN-ONE THEORY WITH PSEUDOVECTOR INTERACTION. Shafi, Q. (Imperial Coll. of Science and Tech., London). Phys. Rev., D; 3: No. 10, 2363-71(15 May 1971).

The conventionally nonrenormalizable theory of massive neutral pseudovector mesons interacting with nucleons is treated in the Stückelberg formalism using some recently developed nonlinear techniques. The theory is split into two parts: a renormalizable interaction of mesons with nucleons, which can be treated by standard methods, and an exponential interaction of pseudoscalar mesons with nucleons, which is dealt with using nonlinear methods. It is shown that all the infinities of the theory may be eliminated by adding suitable counterterms. Thus the complete theory becomes renormalizable. Similar considerations also apply if a parity-violating term is introduced in the original pseudovector interaction. (auth)

33762 ELASTIC $K^{+-}p$ SCATTERING AND A DUAL ABSORPTIVE MODEL. Davier, M.; Harari, H. (Stanford Univ., Calif.). Phys. Lett.; 35B: No. 3, 239-42(24 May 1971).

A recent measurement of the differential cross section for elastic K^+p and K^-p scattering is discussed within the framework of a dual absorptive model which was proposed earlier. The non-Pomeron part of the elastic scattering amplitude is shown to be strongly dominated by the most peripheral partial waves within the interaction radius, namely by the $l \approx qr$ partial waves. (auth)

33763 COMPLEXITY CRITERION FOR UNSTABLE PARTICLES. Pazdzerskii, V. A. (Tashkent State Univ.). Izv. Akad. Nauk Uzb. SSR, Ser. Fiz.-Mat. Nauk; No. 4, 95-6(1970). (In Russian).

The Lagrangian approach to elementary and composite particles and the S-matrix concept in which both types of particles are expressed as S-matrix poles (without and with quasiparticles) were expanded to the nonstable particles using a simple nonrelativistic Lee model in coordinate concept. (R.V.J.)

Strong (Baryon No. ≥ 2)

Refer also to abstract 34193.

33764 (ITF-70-92-E) THREE-NUCLEON PROBLEM WITH REPULSIVE-CORE POTENTIALS. Kharchenko, V. F.; Shadchin, S. A. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 29p. Dep. NTIS (U. S. Sales Only).

The three-nucleon problem with the pair local interaction containing a repulsion at small distances is considered on the basis of Faddeev's formalism using the Hilbert–Schmidt separable representation for the two-particle t-matrix. The problem is reduced to solving the set of integral equations for the functions depending only on one variable. The triton binding energy and the neutron-deuteron scattering lengths are considered for the square-well potential with the infinite repulsive core. The parameters of the pair potential were determined from the data on two-nucleon interaction at the energies of nucleon in the interval from 0 to 400 MeV (in a laboratory system). (auth)

33765 (JINR-E4-5763) CALCULATIONS OF PROPERTIES OF THE THREE-NUCLEON SYSTEMS WITH LOCAL POTENTIALS. Akhmadkhodzaev, B.; Belyaev, V. B.; Wrzecionko, J.; Zubarev, A. L. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 21 Apr 1971. 16p. Dep. NTIS (U. S. Sales Only).

The Faddeev equations for three-nucleon systems are solved for a number of local (including "realistic") potentials with a soft or hard core. The energy and wave functions of the bound states of ^3H and $^3_\Lambda H$ nuclei as well as the doublet and quartet nd-scattering length are calculated. Dependence of the above quantities on the functional shape of potential and the magnitude of singlet effective range is determined. The value of the axial matrix element in beta decay of ^3H and the probability of μ-capture on ^3He nucleus is also computed. The latter calculations make it possible to find the value of weak pseudoscalar coupling constant $g_p = 5.3\, g_A$. (auth)

33766 (JINR-P1-5737) PHASE-SHIFT ANALYSIS OF pp SCATTERING AT 1 GeV. Glonti, L. N.; Kazarinov, Yu. M.; Rozanova, A. M.; Silin, I. N. (Joint Inst. for Nuclear Research,

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Dubna (USSR). Lab. of Nuclear Problems). 1971. 16p. (In Russian). Dep. NTIS (U. S. Sales Only).

In order to plan experiments on the elastic NN-scattering at 1 GeV the phase-shift analysis of the known experimental data on pp-scattering at 1 GeV was performed. The results show that for an accurate determination of the pp-scattering amplitude at this energy, first of all, the measurement of the triple scattering parameters is to be made. Experimental data on the elastic pp-scattering near 1 GeV are listed. (auth)

33767 (NP-18838) THEORETICAL STUDY OF HYPERON-NUCLEON SCATTERING USING A MANY-CHANNEL FORMALISM. Letessier, Jean (Paris Univ. (France). Faculte des Sciences). 1970. 100p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The hyperon-nucleon interaction is studied in a many channel formalism. The total and differential cross sections of $\Lambda N \to \Lambda N$ and $\Sigma N \to \Sigma N$ coupled processes are calculated in the framework of the crossed channel boson exchange model. The $\Lambda N \to \Sigma N$ inelastic channel is introduced by the ND^{-1} matrix method which enables a unitarized low energy contribution of the Regge trajectories exchanged through crossed channels to be obtained by treating together all hyperon-nucleon processes in the $T = 1/2$ isospin state. One of the important characteristics of the model is the complete absence of resonance in the ΛN states as well as the ΣN states, at low energies, for partial waves with an angular momentum <4. (France)

33768 (UCSD-10-P-10-77) DIFFRACTIVE POMERON BOOTSTRAP AND MULTIPERIPHERAL FRAGMENTATION. Silverman, Dennis; Ting, Peter D.; Yesian, Harry J. (California Univ., La Jolla, San Diego. Dept. of Chemistry). [1970]. 13p. Dep. NTIS.

The diffractive Pomeron pole given by $T(s,t) = is\beta(t)$ is derived from a multiperipheral bootstrap where the Pomeron is required to be exchanged only once. This model corresponds to a fragmentation picture and its predictions for inclusive experiments are presented. These predictions are contrasted with those of multi-Pomeron exchange models and shown to provide tests for the nature of the Pomeranchuk singularity. (auth)

33769 REGGE BEHAVIOR IN INCLUSIVE EXPERIMENTS. Peccei, R. D.; Pignotti, A. (Univ. of Washington, Seattle). Phys. Rev. Lett.; 26: 1076-9(26 Apr 1971).

The Regge prediction is discussed for the behavior of inclusive cross sections near the kinematic boundary, and it is compared with a recent conjecture of Chou and Yang. Some existing experimental data are analyzed and, in particular, no evidence is found yet for diffraction dissociation into high masses (three-Pomeranchon coupling). (auth)

33770 ANALYSIS OF THE BOOTSTRAP SUM RULES FOR THE AMPLITUDES OF BARYON-BARYON SCATTERING. Grigor'yants, A. G.; Fil'kov, L. V. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: 392-400(Feb 1971). (In Russian).

The coupling constants obtained with the help of the sum rules in previous work are analyzed. Simultaneous consideration of the sum rules for the amplitudes of the NN, $\Xi\Xi$, $\Sigma\Sigma$, and $\Lambda\Lambda$ scattering makes it possible to determine the constants which were not found previously. In particular, it is shown the smallness of the coupling constants of 1^+ mesons with baryons. The dependence of the interaction constants of π and η mesons with baryons on the hypercharge of the corresponding baryon is found. The meson-baryon coupling constants obtained are compared with predictions of the SU(3) symmetry and with other models. (auth)

33771 IMPORTANCE OF THE D-STATE PROBABILITY OF THE DEUTERON IN THRESHOLD $p + p \to \pi + d$. Thomas, A. W.; Afnan, I. R. (Flinders Univ. of South Australia, Bedford Park). Phys. Rev. Lett.; 26: 906-8(12 Apr 1971).

Using a number of realistic, local and nonlocal, separable two-nucleon interactions, it is shown that threshold s-wave pion production is sensitive to the D-state probability of the deuteron and the nonlocality of the interaction. This enables one to use the reaction $p + p \to \pi^+ + d$ to study the relative strength of the central to tensor potential and the nonlocality of the nucleon-nucleon interaction at short distances. (auth)

33772 GENERATION CROSS SECTIONS OF QUASINUCLEAR MESON RESONANCES. Dal'karov, O. D.; Mandel'tsveig, V. B.; Shapiro, I. S. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 332-5(Feb 1971). (In Russian).

Differential cross sections of production of heavy quasinuclear meson resonances in reactions $\bar{p} + d \to N + x$ and $\bar{d} + p \to \overline{N} + x$ corresponding to stripping and pick up mechanism are calculated. The behavior of differential cross sections as momentum transfer functions is found to be essentially depending on the angular momentum of relative motion of N and $\overline{N}$ that are bound in the quasi-nuclear meson. The total cross sections are found to be $\sigma \approx 1 + 200\ \mu b$. The cross sections of quasinuclear meson production in substitution reactions are given. (auth)

33773 POSSIBLE TIME-REVERSAL NONINVARIANCE IN NUCLEAR FORCES. Bryan, Ronald (Texas A and M Univ., College Station); Gersten, Alexander. Phys. Rev. Lett.; 26: 1000-4(19 Apr 1971).

A model suggested by Sudarshan which relates strong, weak, and electromagnetic interactions through vector and axial-vector currents is adapted to nucleon-nucleon scattering. Strong time-reversal violation is predicted in n-p scattering above 100 MeV through the same mechanism assumed to cause CP-invariance violation in weak hadronic decays. Where a T-invariance violation has been sought for and not found, i.e., in p-p scattering up to 635 MeV and low-energy n-p scattering, the model predicts very little T-invariance violation. (auth)

33774 RADIATIVE CORRECTIONS TO THE ELASTIC πd SCATTERING AMPLITUDE AT HIGH ENERGIES AND SMALL MOMENTUM TRANSFERS. Kondratyuk, L. A.; Kopeliovich, V. B. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 600-7(Mar 1971). (In Russian).

Radiative corrections to the elastic π^+d scattering amplitude contributing to the difference of the total cross sections, $\sigma_t^- - \sigma_t^+$, and of the differential cross sections, $\sigma^-(\theta) - \sigma^+(\theta)$, are expressed through the πN scattering amplitude with account of the radiative corrections and of the deuteron form factor. Unlike the Glauber rescattering correction, important contributions to the radiational corrections are from the rescattering of the nucleons between the electromagnetic and strong pion scattering acts, the fact due to the long-range character of the Coulomb interaction. Measurements of the differences $\sigma_t^- - \sigma_t^+$ and $\sigma^-(\theta) - \sigma^+(\theta)$ with accuracy, better than 0.5%, at $t_{min} \sim 0.01(GeV/c)^2$ may be an independent test of the theoretical predictions on the value of the radiation corrections to the πN scattering amplitude. It is shown that assuming the conventional value of these corrections the difference $\sigma_t^- - \sigma_t^+$ that is positive at $E_\pi \leq 2$ GeV, is to change its sign with energy increase. (auth)

33775 ON THE SEPARATION OF THE ELASTIC COMPONENT IN DOUBLE-SCATTERING COLLISIONS OF HIGH-ENERGY HADRONS IN DEUTERIUM. Bradamante, F.; Conetti, S.; Fidecaro, M.; (and others) (CERN, Trieste, Italy). Nucl. Phys.; B28: 349-67(1971).

In connection with an experiment on hadron–deuteron elastic scattering at high energy, the problem of selecting the elastic events $xd \to xd$ from the inelastic events $xd \to xpn$ is analyzed. When this last reaction is contributed by double-scattering collisions, the proton is expected to have kinematics similar to those of the elastic deuteron. The multiple scattering model is applied to work out angle and momentum distribution both for the scattered hadron and the recoil proton. Also, some of the features of the model are discussed separately, for the two cases in which either single- or double-scattering collisions are predominant: the double-scattering process at variance with the single scattering one is well described as two successive collisions on two free nucleons. It is shown that for a given scattering angle of the hadron the proton from the inelastic double-scattering reaction is distributed around a cone of $\approx 10°$, so that the selection of the elastic deuteron events can be achieved on the basis of the angular correlation between the scattered hadron and the recoil charged particle. Some of the distributions are compared with the ones obtained experimentally for 9 GeV/c negative pions. (auth)

33776 VALUATION OF THE FLUXES OF SECONDARY PARTICLES PRODUCED IN HIGH-ENERGY PROTON COLLISIONS. Cocconi, G. (CERN, Geneva). Nucl. Phys.; B28: 341-8(1971).

Simple expressions for the fluxes of secondaries produced by protons colliding either with another proton beam (ISR) or with a proton at rest are derived using the general empirical properties of strong interactions. (auth)

33777 RECOIL EFFECTS IN HIGH-ENERGY HADRON–DEUTERON COLLISIONS. Faeldt, Goeran (Cambridge Electron Accelerator, Mass. Harvard Univ., Cambridge, Mass.). Nucl. Phys.; B29: 16-28(1971).

Recently the pion-deuteron cross section was measured for momentum transfers up to $\Delta^2 \approx 2(GeV/c)^2$ and compared with Glauber's multiple scattering theory. It is shown that for such large momentum transfers there will be a correction to Glauber's formula which decreases the theoretical cross section by about 15%. It is due to the internal deuteron motion which coupled to the momentum transfer Δ will cause large fluctuations in the nucleon recoil energy. (auth)

33778 INVESTIGATION OF NEUTRON–DEUTERON SCATTERING WITH THE SEPARABLE INTERACTION. Peacock, Richard Wesley. New Orleans; Tulane Univ. (1970). 132p. University Microfilms Order No. 71-8079.

Thesis.

A study of nucleon-deuteron scattering was undertaken using the theory of three particle states as developed previously. First a study of the zero-energy parameters using the Yamaguchi and the Tabakin potentials was performed. A calculation of the quartet and doublet scattering lengths and the three-body binding energy was made for the Yamaguchi and the four cases of the Tabakin potential. Second, using the Yamaguchi and one case of the Tabakin potential, angular distributions were calculated for an incident neutron energy of 2.45 MeV. Finally, the integral equations for the case of inclusion of tensor forces are derived for quartet and doublet cases in order to facilitate angular distribution and polarization calculations in the future. (Diss. Abstr. Int., B)

33779 LOW ENERGY Λ-^{4}He SCATTERING. Khrylin, B. A. (Inst. of Atomic Energy, Moscow). Phys. Lett.; 35B: No. 3, 191-2(24 May 1971).

The parameters of low energy Λ-^{4}He scattering are calculated. (auth)

33780 SCATTERING AMPLITUDE FOR PION–DEUTERON BREAKUP REACTION. Lin, F. C. (National Taiwan Univ., Taipei). Lett. Nuovo Cim.; 1: No. 21, 861-5(22 May 1971).

The Faddeev–Lovelace equation for the scattering amplitude for the pion-deuteron breakup process is evaluated for S-wave low-energy scattering. The method can be generalized to higher angular-momentum states. (L.B.S.)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 33986.

33781 (ITF–70-88-E) ON TWO-COMPONENT EQUATIONS FOR ZERO MASS PARTICLES. Fushchich, V. I.; Grishchenko, A. L. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 22p. Dep. NTIS (U. S. Sales Only).

A detailed theoretical-group analysis of three types of two-component equations of motion which describe the particle with zero mass and spin $\frac{1}{2}$ are presented. The P-, T-, and C-properties of the equations obtained are studied. (auth)

33782 (ITF–71-2-P) ON THE PTC-NON-INVARIANT LAGRANGIANS. Fushchich, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 7p. (In Russian). Dep. NTIS (U. S. Sales Only).

The Lagrangians noninvariant under the PTC-transformations are constructed by the Casimir operators (the energy sign and helicity) of the proper Poincaré group. (auth)

33783 (JINR–E2-5747) SPHERICAL FUNCTIONS OF THE LORENTZ GROUP ON THE TWO-DIMENSIONAL COMPLEX SPHERE OF THE ZERO RADIUS. Huszar, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 9p. Dep. NTIS (U. S. Sales Only).

Spherical functions of the Lorentz group with respect to the horyspheric subgroup are derived and their relation to Gelfand's homogeneous functions are discussed. (auth)

33784 (JINR–P2-5740) ELEMENTS OF THE THEORY OF THE LIE GROUPS AND THE THEORY OF THEIR REPRESENTATIONS. Lebedenko, V. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 74p. (In Russian). Dep. NTIS (U. S. Sales Only).

Initial information from the theory of the Lie groups and the theory of their representations is given. (auth)

33785 (LA–4517) DIFFERENTIAL EQUATIONS INVARIANT UNDER TWO-PARAMETER LIE GROUPS WITH APPLICATIONS TO NONLINEAR DIFFUSION. Axford, Roy Arthur (Los Alamos Scientific Lab., N. Mex.). Aug 1970. Contract W-7405-eng-36. 39p. Dep. NTIS.

Two general problems are considered, viz., the determination of the general forms of second-order, linear and nonlinear, ordinary differential equations that are invariant under two-parameter Lie groups, and the exploitation of invariance properties to solve nonlinear differential equations that arise in diffusion phenomena. (auth)

33786 BOOSTING MATRIX ELEMENTS FOR O(3,1) AND CONTINUATION TO O(4). Smorodinskii, Ya. A.; Shepelev, G. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 441-53(Feb 1971). (In Russian).

A new integral representation for the finite hyperbolic rotation (boosting) matrix element in the Lorentz group is obtained. Continuation to the group O(4) leads to a result coinciding up to a normalization factor with the complex-conjugated formula by Friedman and Wong. An explicit expression is obtained for transformation of the Lorentz-group spinors at the hyperbolic rotation. (auth)

33787 FINITE TRANSFORMATIONS IN VARIOUS REPRESENTATIONS OF SU(3). Rosen, S. P. (Purdue Univ., Lafayette, Ind.). J. Math. Phys. (N. Y.); 12: No. 4, 673-81(Apr 1971).

A projection operator expansion is used to obtain the explicit forms of finite transformations in the triplet, octet, and decuplet representations of SU(3). The projection operators are obtained from the characteristic equations for the matrices in these representations. These characteristic equations are developed from known properties of the λ_i, F_i, and decuplet matrices; where multiple eigenvalues appear, it is shown that the relevant matrices also satisfy reduced equations in which no eigenvalue appears twice or more. General features of the method are discussed. (auth)

33788 NOTE ON NONLINEAR REALIZATIONS OF CONFORMAL SYMMETRY. Hankey, Alex (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 3: No. 10, 2543-6(15 May 1971).

Using methods previously applied to chiral symmetry, the nonlinear realizations of the conformal group that are linear with respect to the Poincaré group are developed. This derivation agrees with previous results and shows that the realization is unique. The covariant derivatives are obtained in the same way. (auth)

33789 SPONTANEOUSLY BROKEN SYMMETRY AND CONFORMAL INVARIANCE. Castell, L. (Max-Planck Institut fuer Physik und Astrophysik, Munich). Phys. Rev., D; 3: No. 10, 2530-1(15 May 1971).

A necessary condition for spontaneously broken dilatational and conformal symmetry is that the length dimension of the field $\varphi(y)$ is different from zero. If we consider the opposite situation in which a chargelike symmetry is broken in the framework of full conformal invariance, a massive Goldstone mode is obtained, which couples conformal-invariantly to 2γ, and which is therefore identified with the π or η. The corresponding local field theory is defined in a five-dimensional space. In (the conformal compactification of) Minkowski space the Goldstone situation cannot arise. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstract 34092.

33790 (PURC–4159-24) SEARCH FOR VIOLATION OF CP INVARIANCE IN THE DECAY OF $K^\pm$ MESONS INTO THE τ MODE. Technical Report No. 7. Souder, Paul Allen (Princeton Univ., N. J. Elementary Particles Lab.). Feb 1971. Contract AT-(30-1)-4159. 177p. Dep. NTIS.

In a search for violation of CP invariance in τ decay the Dalitz-plot distributions of 1.6 million τ^+ decays ($K^+ \to \pi^+\pi^+\pi^-$) and an equal number of τ^- decays ($K^- \to \pi^-\pi^-\pi^+$) were compared. This experiment was performed in a 3-GeV/c partially separated beam at the Brookhaven AGS. Kaons decaying into three pions were detected by a threefold coincidence in an eight-counter hodoscope. The directions of all three pions were measured in a set of five wire spark chambers, and a wide-aperture spectrometer magnet and six more wire spark chambers served to determine the momentum of the odd pion. The data were taken and analyzed in exactly the same way for both positive and negative beams. Numerous checks were made to ensure that the apparatus treated both decays identically. No statistically significant difference between τ^+ and τ^- decay was found in any region of the Dalitz plot. In terms of the slope parameters a^+ and a^- for the odd pion energy spectra in the rest frame of the kaon, the asymmetry is: $\Delta = (a^+ - a^-)/(a^+ + a^-) = -0.0070 \pm 0.0053$. These results are consistent with no CP violation in τ decay. (auth)

33791 (SU-1206-245) ΔI = MASS DIFFERENCES AND $\eta \to 3\pi$ DECAY. Schechter, J.; Ueda, Y. (Syracuse Univ., N. Y.

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Dept. of Physics). [1970]. 32p. (NYO-3399-245). Dep. NTIS.

The octet baryon $\Delta I = 1$ mass shifts, kaon electromagnetic mass shift, and $\eta \to 3\pi$ decay amplitude are all correlated in the framework of the linear SU(3) sigma model. It is shown how this model provides a natural realization of the "tadpole" idea of Coleman and Glashow. An attempt is made to resolve the long standing mystery associated with the $\eta \to 3\pi$ process and the rare mode $\eta' \to 3\pi$ is also calculated. Finally it is shown that the chiral breaking and isospin breaking coefficients in the Lagrangian have the same order of magnitude. (auth)

33792 C-INVARIANCE VIOLATION AND THE ISOTENSOR CURRENT. Sanda, A. I. (Columbia Univ., New York); Shaw, Graham. Phys. Rev. Lett.; 26: 1057-60(26 Apr 1971).

A model is suggested in which the isotensor electromagnetic current, whose existence is strongly suggested by recent work, has a component which violates charge-conjugation invariance, which, on the other hand, is satisfied by the conventional isovector and scalar components. This is found to provide a simple explanation of recent results, and is consistent with all present experimental knowledge. (auth)

33793 RELATIONSHIP BETWEEN CHARGE CONSERVATION AND LOCAL CURRENT CONSERVATION. Saenger, Robert M. Univ. of Minnesota, Minneapolis. Florida Technological Univ., Orlando). Contract AT(11017-1764). Phys. Rev., D; 3: No. 10, 2348-50(15 May 1971).

The question of whether total charge conservation requires local current conservation is studied in terms of the Fourier transform of the current's divergence. This approach allows classical and quantum cases to be treated similarly. The crucial criterion for current conservation is found to be analyticity of the divergence as a function of the momentum variable q^μ. This criterion is closely linked to causality. Simple models are given in which current is not conserved locally but which still permit total charge conservation in all frames. (auth)

33794 NONLINEAR UNITARY SYMMETRY. Love, A.; Ross, G. G. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Lett.; 35B: No. 3, 231-3(24 May 1971).

The sum rules arising from Weinberg's algebraic realization techniques for nonlinear SU_3 symmetry are examined. Octet enhancement for electromagnetic mass differences is motivated by reducing the linear subalgebra to $U_1 \times U_1$. Finally, some dynamical features of the model are presented. (auth)

33795 SEARCH FOR CP-VIOLATION IN $K^0 \to \pi^+\pi^-\pi^0$ DECAYS. James, F. (CERN, Geneva); Montanet, L.; Paul, E.; (and others). Phys. Lett.; 35B: No. 3, 265-8(24 May 1971).

The time distribution of $\pi^+\pi^-\pi^0$ decays of the neutral K meson produced in the reaction $K^+p \to K^0p\pi^+$ with K^+ momenta at 1.4 and 1.7 GeV/c was studied. Within our fiducial volume 98 uniquely identified $\pi^+\pi^-\pi^0$ decays with proper times between 0.04 and 20 K_s lifetimes were obtained. For the ratio η_{+0} of the amplitude $K_s \to \pi^+\pi^-\pi^0$ to the amplitude $K_L \to \pi^+\pi^-\pi^0$, it is found that: Re $\eta_{+0} = 0.01 \pm {}^{0.38}_{0.28}$, Im $\eta_{+0} = 0.33 \pm {}^{0.41}_{0.36}$. This result is consistent with no CP-violation. Assuming $\eta_{+0} = 0$, the rate $\Gamma(K_L \to \pi^+\pi^-\pi^0) = 2.5 \pm 0.3)\ 10^6\ \text{sec}^{-1}$ was found. (auth)

Applications (Strong)

Refer also to abstract 33679.

33796 (ITF-70-102-E) REVIEW OF HADRON SYMMETRIES: MULTIPLETS, SUPERMULTIPLETS AND INFINITE MULTIPLETS. Barut, A. O. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 103p. (CONF-700806-60). Dep. NTIS (U. S. Sales Only).

From fifteenth international conference on high energy physics; Kiev, USSR (26 Aug 1970).

A review is given of the classification scheme of hadron states and hadron structure, especially the high-lying excited states. Hadron quantum number, properties, and multiplets, the naive quark model for high-lying states, relativistic treatment of orbital and radial excitations, passage to dynamical groups and infinite multiplets, current algebra and infinite hadron states, and implications of other hadron models for hadron states are treated. Also considered are a simple proton model, and mathematical results. (J.F.P.)

33797 EXACT CONSEQUENCES OF BROKEN O(4) SYMMETRY. III. FACTORIZATION AND MASS DEPENDENCE. Bronzan, J. B.; Sukhatme, Uday P. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., D; 3: No. 10, 2506-15(15 May 1971).

Analyticity arguments are used to obtain the constraints imposed by factorization and broken O(4) symmetry on Regge daughter sequences coupled to spinless external particles. The results hold for arbitrary external masses. (auth)

33798 DYNAMIC AND ALGEBRAIC SYMMETRIES. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). pp 283-393 of Lectures on Elementary Particles and Quantum Field Theory. Vol. 1. /Deser, Stanley (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The exploration of symmetries of the Lagrangian which are not symmetries of the Hilbert space are discussed. Hadron electrodynamics, which is an interplay between algebraic and dynamic symmetries, and local dynamic symmetries are treated, and the results are applied to the chiral invariant theory of pions. (J.F.P.)

Field Theories

General

Refer also to abstracts 33628 and 34165.

33799 FOURTH-ORDER GRAVITATIONAL POTENTIAL BASED ON QUANTUM FIELD THEORY. Iwasaki, Y. (Kyoto Univ.). Lett. Nuovo Cim.; 1: No. 19, 783-6(8 May 1971).

The fourth-order potential is explicitly calculated from quantum theory in the cases of the scalar field and the Dirac field. (L.B.S.)

33800 COMPLEX POLES, CUTS, INDEFINITE METRIC, AND UNITARITY. Nagy, K. L. (Roland Eoetvoes Univ., Budapest). Acta Phys. Acad. Sci. Hung.; 29: No. 2-3, 251-65(1970).

In connection with Lee–Wick's electrodynamics, unitarity problems are discussed on exactly soluble models with complex ghosts. (auth)

33801 QUANTUM BIANCHI IDENTITIES AND FIELD EQUATIONS FOR GENERAL RELATIVITY. Russo, M. (Northeastern Univ., Boston). Contract F 33615-69-C-1207. Phys. Rev., D; 3: No. 10, 2325-32(15 May 1971).

By invoking the physical symmetry of coordinate invariance for the matter-free gravitational field, the contracted quantum Bianchi identities are derived from a family of Hermitian Lagrangians which are the quantum analogs of the Palatini Lagrangian. It is further shown that these gauge-variational techniques yield a set of necessary conditions that determine whether the quantum field equations and contracted Bianchi identities contain purely quantum structures of order $\hbar^2$ which possess no classical analogs. (auth)

33802 PERTURBATION THEORY ANOMALIES. Adler, Stephen L. (Inst. for Advanced Study, Princeton, N. J.). pp 1-164 of Lectures on Elementary Particles and Quantum Field Theory. Vol. 1. /Deser, Stanley (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

Some recent developments in renormalized perturbation theory are studied. The VVA triangle anomaly and its consequences, absence of radiative corrections, generalizations of results on π^0 decay and other Ward identity anomalies, connection between Wark identity anomalies and commutator anomalies, applications of the Bjorken limit, and breakdown of the Bjorken limit in perturbation theory are discussed. (J.F.P.)

Quantum Field Theory

Refer also to abstracts 33574, 33625, 33711, 33724, 33728, 33761, 33850, and 33859.

33803 (IC–71/13) GAUGE-INVARIANT INFINITY SUPPRESSION IN GRAVITY-MODIFIED QUANTUM ELECTRODYNAMICS. Isham, C. J.; Salam, Abdus; Strathdee, J. (International Centre for Theoretical Physics, Trieste (Italy)). Apr 1971. 18p. Dep. NTIS (U. S. Sales Only).

It is argued that the use of a visibly localizable parametrization of the gravitational interaction yields a number of advantages. Firstly, the question of ambiguities can be completely solved: according to a theorem of Lehmann and Pohlmeyer there exists in such theories a unique "minimally singular" solution which it is natural to adopt as the physical one. Secondly, it is possible to show that this solution satisfies the usual requirements of analyticity and unitarity in the sense of perturbation theory. Thirdly, it is possible to arrange the computations in a manifestly gauge independent manner. These points are briefly reviewed; the main object is to introduce a new technique for the treatment of those nonpolynomial Lagrangians in which the interaction terms are

intimately associated with the free part. The gravity-modified theories exemplify this type of Lagrangian: in such theories the zero-graviton approximant to any process is "cradled" in a sequence of graphs with arbitrarily large numbers of gravitons whose sum exists, is finite, free of ambiguities and gauge independent to any required order. (auth)

33804 (ITF-71-5-E) ELECTROMAGNETIC INTERACTIONS. THEORY. Solov'ev, L. D. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 60p. (CONF-700806-59). Dep. NTIS (U. S. Sales Only).

From 15 international conference on high energy physics; Kiev, USSR (26 Aug 1970).

A review is given of new theoretical results on quantum electrodynamics in higher orders at low and high energies and in models, lepton-hadron scattering for the deep inelastic scattering of electrons on nucleons and the form factors of elastic scattering, and photon-hadron Compton scattering. (J.F.P.)

33805 (ITF-71-7-E) WEAK CONVERGENCE IN THE INFINITE TENSOR PRODUCT OF HILBERT SPACES. Burban, I. M. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1971. 7p. Dep. NTIS (U. S. Sales Only).

The weakly convergent series of operators in the incomplete infinite tensor product of Hilbert spaces are investigated. It is proved that the limiting operator will be essentially self-adjoint when a dense domain exists where the sequencies of partial sums of the positive operators weakly converge. (auth)

33806 RELATIVISTIC MECHANICS. SPECIAL RELATIVITY AND CLASSICAL PARTICLE DYNAMICS. Sard, R. D. Lecture Notes and Supplements in Physics. New York; W. A. Benjamin, Inc. (1970). 395p.

The topics considered are coordinate transformations, special relativity, accelerated reference frames, the Lorentz transformation and the kinematics of a particle, dynamics of a particle, transitions of a system, conservation of four-momentum, the mass-energy relation, and relativistic kinematics. Also successive Lorentz transformations, motion of spin, equivalence principle, and motion in a weak gravitational field are covered. (J.F.P.)

33807 VECTOR BUNDLES IN MATHEMATICAL PHYSICS. VOLUME I. Hermann, Robert. Mathematics Lecture Note Series. New York; W. A. Benjamin, Inc. (1970). 452p.

The topics discussed are jet bundles and the classical calculus of variations, connections in vector bundles and Yang-Mills fields, the Euler-Lagrange operator in terms of differential forms and jet bundles, the symplectic structure on the space of extremals with application to quantum field theory, vector bundles and representations of semidirect product groups, and Poincare-invariant differential operators and bundles. Also some general properties of Poincare-invariant differential operators, and Fock space and free quantum fields are considered. (J.F.P.)

33808 THEORY OF YANG-MILLS FIELDS. Tyutin, I. V.; Fradkin, E. S. (Lebedev Inst. of Physics, Moscow). Yadern. Fiz.; 13: 433-40(Feb 1971). (In Russian).

Arguments are presented in favor of the fact that the theory of the Yang-Mills field (massive and massless) is nonanalytical in the coupling constant and that the $m \to 0$ limit of the massive theory exists and coincides with the massless theory. (auth)

33809 ROLE OF GAUGE FIELD IN THE SPONTANEOUS BREAKDOWN OF SYMMETRY. Aurilia, A. (Univ. of Alberta, Edmonton); Takahashi, Y.; Umezawa. Lett. Nuovo Cim.; 1: No. 15, 603-6(10 Apr 1971).

In previous investigations of spontaneous breakdown of gauge symmetry it was concluded that the original gauge field becomes massive without any trace of the Goldstone boson on the light cone. The excitation of physical states is investigated in the Nambu-Jona-Lasinio model, under the requirement that the chiral gauge invariance must be maintained at every stage. It is found that in the pair approximation the physical vector field consists of a massive field, a massless vector field, and a phase field, and that the two chiral gauge transformations are carried by the massless vector and phase fields, respectively. (L.B.S.)

33810 DISPERSION SUM RULES IN QUANTUM FIELD THEORY. Miranskii, V. Zinov'ev, G. M. (Inst. for Theoretical Physics, Kiev). Lett. Nuovo Cim.; 1: No. 15, 612-16 (10 Apr 1971).

An analytic approach to the dispersion sum rules is suggested which leads to the superconvergence sum rules and finite-energy sum rules. (L.B.S.)

33811 CONSERVATION OF AXIAL CURRENT IN MASSLESS ELECTRODYNAMICS. Dolgov, A. D.; Zakharov, V. I. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz.; 13: 608-19(Mar 1971). (In Russian).

Imaginary parts of triangle graphs are calculated for transitions of the axial current and of the pseudoscalar density into two photons. It is shown that the formal consequences from the γ_5 invariance (in the limit of zero electron mass) are violated in the imaginary part of the amplitude. The result is a nonconservation of the axial current in the massless electrodynamics in case of the triangle graph. Examples are also presented of rapidly convergent loop graphs and of the tree graphs for which the current conservation is violated in case of a particular configuration of the external momenta. It is shown that if the electron mass is nonzero one can get an agreement between the results of perturbative calculations and the consequences from the equations of motion for the axial current divergence choosing a particular way to calculate the triangle graph. (auth)

33812 NEW APPROACH TO THE THEORY OF RELATIVITY. Kar, K. C. Calcutta; Institute of Theoretical Physics (1970). 51p.

The treatment of relativistic problems covers the classical theory of relativity, the Einstein theory of relativity and the Lorentz transformation, vectors in the theory of relativity, the vector test of Lorentz-Maxwell electromagnetic equations, relations between electric and magnetic intensities in moving and fixed systems and Lorentz invariance of the electromagnetic equations. Mass, momentum, and energy, the relativistic Hamiltonian and its linearization, and invariance of the Lorentz mechanical equation, are discussed. Also included are the nature of acoustical and optical waves and the scalar character of wave velocities, the fundamentals of relativity, relativity in the acoustical world, the acoustical and the optical Doppler effect, and mass, momentum, and energy in acoustical relativity. (J.F.P.)

33813 POSSIBILITY OF RELATIVISTIC QUANTUM MECHANICS. Droz-Vincent, P. (Institut Henri Poincare, Paris). Lett. Nuovo Cim.; 1: No. 19, 800-2(8 May 1971).

The possibility of formulating relativistic quantum mechanics different from quantum field theory is examined using classical relativistic mechanics as a guide. A model is considered where a system of N particles is described by a N-parameter translation group parametrized by the proper times and acting on the product of N copies of the individual phase space suitable to the case of a unique particle. Axioms are given for a quantum counterpart of this point of view. (L.B.S.)

33814 RELATIVISTIC BOUND STATES AND CROSS SECTIONS. Walter, J. F.; Marx, E. (Drexel Univ., Philadelphia). Nuovo Cim.; 3B: No. 1, 119-33(11 May 1971).

The role of stationary states is considered within the context of relativistic quantum mechanics. It is found that one can obtain energy levels for bound states and scattering cross sections for particles, but that a probabilistic interpretation of the wave function requires the introduction of quasi-stationary states, and the determination of a cross section for pair annihilation leads to the use of time-dependent perturbation theory. (auth)

33815 CANONICAL QUANTIZATION OF CHIRAL DYNAMICS. Dowker, J. S.; Mayes, I. W. (Univ. of Manchester, Eng.). Nucl. Phys.; B29: 259-68(1971).

The general covariance of quantized chiral dynamics is taken to be equivalent to the general covariance of the Schrödinger equation for the state functional in the canonical approach. The resultant ordering introduces terms proportional to $[\delta^3(0)]^2$ into the Hamiltonian used in the functional integral representation of the generating functional. From the Lagrangian point of view these terms arise because of the stochastic nature of the path integration and show that one must be careful when discussing such properties as general covariance or invariance in a functional approach. Some consequences are discussed. (auth)

33816 TOWARD A LAGRANGIAN THEORY OF CURRENTS FOR INTERACTING HADRONS. Beckerman, M.; Wojtaszek, J. H. (Univ. of Miami, Coral Gables, Fla.). Nucl. Phys.; B29: 160-8(1971).

An attempt is made to obtain a theory of currents from a Lagrangian model describing interacting pseudoscalar mesons and quarks. Upon introducing appropriate Schwinger terms in the current algebra, the parity doubling problem is avoided, the Schwinger covariance condition is verified and the current conservation equations are obtained. (auth)

33817 RARITA-SCHWINGER EQUATION FOR THE VECTOR-SPINOR FIELD. Baisya, Hira L. (Trinity Coll., Dublin). Nucl. Phys.; B29: 104-24(1971).

It has been shown that the Rarita-Schwinger equation for the

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vector-spinor field with arbitrary parameters has three solutions for some values of the parameters; for some other values it has two solutions. It is also seen that the Umezawa–Visconti formula for the highest order of derivative in the reciprocal operator is not satisfied in the case of Rarita–Schwinger vector-spinor field. The electromagnetic interaction of the vector-spinor field is discussed. By a new formalism in quantization it is shown that $\psi(\chi) = \psi(\chi/\sigma)$ holds even in case of Rarita–Schwinger field and the interacting spin $^3/_2$ field has been quantized. It is seen that the interaction Hamiltonian is not an infinite series of the coupling constant. (auth)

33818 SOME COVARIANT IDENTITIES AND THE GENERATORS OF THE POINCARE GROUP. Takahashi, Y. (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A; 71: No. 1, 1-11(1971).

Some identities convenient for covariant calculations occurring in relativistic quantum field theory are derived. These identities enable one to calculate directly the commutator of the generator of a certain transformation with the energy-momentum and the angular-momentum operators. The uniqueness of the energy-momentum tensor is also discussed. The generator of the dilatation transformation is considered. Since the field commutators are never used explicitly in the calculation, the argument is valid even for fields obeying parastatistics. (auth) (UK)

33819 QUANTUM THEORY OF MANY-PARTICLE SYSTEMS. Fetter, Alexander L.; Walecka, John Dirk. International Series in Pure and Applied Physics. New York; McGraw-Hill Book Company (1971). 614p. $19.95.

A unified and self-contained treatment of many-particle systems is presented. The formalism of nonrelativistic quantum field theory is developed and applied to various model systems. Also covered are nuclear matter, interacting electrons and phonons, superconductors, superfluid helium, and finite nuclei. (J.F.P.)

33820 MAJORANA REPRESENTATION OF THE GENERALIZED DIRAC EQUATION. Corinaldesi, Ernesto. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur.; 68: 615-24(Jun 1970). (In Italian).

The generalized Dirac equation formulated previously for particles of arbitrary spin is expressed in a form which is the natural extension of the Majorana representation. (auth)

33821 POSSIBILITY OF MEASURING THE THIRRING EFFECT. Frehland, Exkart (Univ., Freiburg i. B.). Nature (London) Phys. Sci.; 230: 11-12(1 Mar 1971).

Two possible methods of verifying experimentally the Thirring effect are discussed. Firstly an experiment is considered in which the Coriolis force K could be measured with the help of a beams magnetic suspension system. Alternatively an arrangement similar to a gravity torsion balance could be used. (UK)

33822 LECTURES ON ELEMENTARY PARTICLES AND QUANTUM FIELD THEORY. VOLUME 1. 1970 Brandeis University Summer Institute in Theoretical Physics. Deser, Stanley; Grisaru, Marc; Pendleton, Hugh (eds.). Cambridge, Mass.; Massachusetts Institute of Technology Press (1970). 598p. $7.95.

There were four lectures included. Separate abstracts were prepared for all lectures. (J.F.P.)

For abstracts of individual lectures see: 33680, 33798, 33802, and 33823.

33823 LOCAL OPERATOR PRODUCTS AND RENORMALIZATION IN QUANTUM FIELD THEORY. Zimmerman, Wolfhart (New York Univ., N. Y.). pp 395-589 of Lectures on Elementary Particles and Quantum Field Theory. Vol. 1. /Deser, Stanley (ed.). Cambridge, Mass.; Massachusetts Inst. of Tech. Press (1970).

The problem of defining local operator products in quantum field theory is discussed. The topics covered are renormalization, operator product expansions, and local field equations. (J.F.P.)

33824 HIGH-ENERGY TWO-BODY PROBLEM IN QUANTUM FIELD THEORY. Martinis, M. (Inst. Rudjer Boskovic, Zagreb). Lett. Nuovo Cim.; 1: No. 21, 843-8(22 May 1971).

The treatment of the relativistic two-body equation in quantum field theory by means of the Bethe–Salpeter equation is considered. The simple ladder approximation of the Bethe–Salpeter equation is known to lead to the scattering amplitude which does not sum to the correct eikonal form at high energies. An attempt is made to find other relativistic two-body equations that give the same on-shell scattering amplitude, and are more suitable for high-energy considerations. (L.B.S.)

33825 DIVERGENCE OF STRESS TENSORS IN EXTERNAL FIELDS. Deser, S. (Brandeis Univ., Waltham, Mass.). Lett. Nuovo Cim.; 1: No. 21, 866-8(22 May 1971).

It is pointed out that the stress tensor of a system is no longer conserved when external fields are present, owing to local energy transfer between the dynamic and external fields. An expression for the divergence Δ^μ of the stress tensor in the presence of an external vector field is derived. A comment is made on the relation of the form Δ^μ to equal-time commutation relation. (L.B.S.)

33826 NEW LAGRANGIAN FORMALISM FOR INFINITE-COMPONENT FIELD THEORIES. Chodos, Alan (Univ. of Pennsylvania, Philadelphia); Cooper, Fred. Phys. Rev., D; 3: No. 10, 2461-72(15 May 1971).

The infinite-component wave equation $(\partial_\mu L^\mu - M)\varphi = 0$, whose fields are an infinite sum of $(^1/_2k,^1/_2k)$ representations of the Lorentz group, is shown to be invariant under a set of gauge transformations of the second kind. A new class of second-order Lagrangians which are invariant under these gauge transformations is considered. The Lagrangians are a generalization to the infinite component field of the ordinary Stueckelberg formalism for a spin-1 field. In this new formalism ordinary field-theory techniques can be used to discuss canonical quantization and to introduce local interactions. Two separate theories are explored, one with full invariance under the gauge transformation, and one with invariance only under a restricted set of transformations $[(\Box^2 + \overline{m}^2)\Lambda(x) = 0]$. The former theory presents a natural framework for discussing the ρ trajectory and conserved vector currents with an infinite number of poles. The gauge current in that theory is conserved, contains the ρ and ρ daughters, and has finite c-number Schwinger terms (as in the algebra fields). The latter theory seems a possible framework for the π-A_1 trajectory, the axial-vector obeying a generalized PCAC (partial conservation of axial-vector current) relation. (auth)

33827 ASYMPTOTIC FORM OF THE ELECTRON PROPAGATOR AND THE SELF-MASS OF THE ELECTRON. Baker, M. (Univ. of Washington, Seattle); Johnson, K. Contracts AT(30-1)-2098; AT(45-1)-1388B; AT(30-1)-3829. Phys. Rev., D; 3: No. 10, 2516-26(15 May 1971).

The electron self-mass problem is discussed in the context of ordinary renormalized quantum electrodynamics. All perturbation contributions to the renormalized self-energy part $\Sigma(p)$, which diverge logarithmically or remain constant in the limit when $p \gg m$, are summed. The resulting $\Sigma(p)$ vanishes in the limit $p^2/m^2 \to \infty$ and yields a value for δm which is finite and equal to m. To obtain this result it is only assumed that the exact photon Green's function at small distances behaves like the bare propagator, which is the case if the eigenvalue equation for the bare coupling constant has a finite root. It is shown that in spite of the fact that the resulting mechanical mass m_0 vanishes identically, no conservation equation is obtained for any axial-vector current. Hence no Goldstone bosons appear in ordinary quantum electrodynamics when it is summed to all orders. (auth)

33828 SIMPLIFIED EQUATION FOR THE BARE CHARGE IN RENORMALIZED QUANTUM ELECTRODYNAMICS. Baker, M. (Univ. of Washington, Seattle); Johnson, K. Contracts AT(30-1)-2098; AT(45-1)-1388B; AT(30-1)-3829. Phys. Rev., D; 3: No. 10, 2541-2(15 May 1971).

The bare coupling constant of quantum electrodynamics, if finite, is the zero of the Gell–Mann–Low function ψ. It was previously shown that the zeros of a function f are also zeros of ψ. The quantity f is the sum of the coefficients of the single power of the logarithm of a cutoff present in every order of perturbation theory in the vacuum polarization, omitting all those diagrams which include insertions in single internal photon lines. The converse is shown; the zeros of ψ are also zeros of f. It is further shown that the zeros of ψ are zeros of a still simpler function f_1, which is defined analogously to f, but with the exclusion of all diagrams which contain multiple closed electron loops. (auth)

33829 DETERMINATION OF e/h WITH THE HELP OF THE JOSEPHSON EFFECT. Kose, V.; Melchert, F.; Fack, H.; Schrader, H.-J. PTB Mitt.; 81: 8-10(Feb 1971). (In German).

The quotient of the electron charge e and Planck's constant h is measured by means of the ac Josephson effect. A Josephson dc voltage of about 1 mV is compared with the volt as maintained at the PTB (V_{PTB}). The measuring circuit and experimental set-up is described. The preliminarily measured value is $2\,e/h = (483\,593{,}7 \pm 0{,}2)\,10^9\ \mathrm{Hz}/V_{PTB}$. (auth)

33830 BOOTSTRAPS IN LOCAL FIELD THEORY. Whippman, M. L. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., D; 3: No. 10, 2372-6(15 May 1971).

The problem of formulating a bootstrap in terms of vanishing

renormalization constants is discussed. It is pointed out that the equations Z = 0 need not determine masses and coupling constants, but might be identities or else possess no solution. It is argued that this always occurs in theories in which particles are treated as made up of arbitrarily many other particles, and this is illustrated in a soluble model. Finally, various consequences of this idea are mentioned. (auth)

33831 LORENTZ-INVARIANT LOCALIZATION FOR ELEMENTARY SYSTEMS. III. ZERO-MASS SYSTEMS. Kalnay, A. J. (International Centre for Theoretical Physics, Trieste, Italy. Univ. Central de Venezuela, Caracas). Phys. Rev., D; 3: No. 10, 2357-63(15 May 1971).

The present series of papers is devoted to the localization problem in relativistic quantum mechanics. The consequences of imposing the condition that the descriptions of a localized state seen from two different frames of reference should be physically consistent were investigated in Paper II. Only instantaneous localization was studied. Considering elementary systems of nonzero mass and spin 0 and ½, the following results were found. (a) As regards the localization problem, one cannot avoid accepting at least one of the following strong departures from the usual ideas: (i) Position has no meaning; (ii) it violates the physical equivalence of inertial frames; (iii) it is the only quantum variable which cannot be represented by an operator; (iv) it is non-Hermitian; (v) some unusual interaction effects do not disappear when the interaction is switched off. (b) If a component of position is to be precisely measurable as a point, then for spin 0 there is only one possible position operator; for spin ½ the operator is unique up to a parameter; in both cases the operators are non-Hermitian with respect to the relativistically invariant scalar product, but in spite of this the eigenvalues of all components are real. The components of position are compatible with each other for spin 0 and incompatible for spin ½. The commutation relations of position with linear momentum are the standard ones. The velocity operator, which is Hermitian, has the expected form. Several authors have stated that the localization problem can have a solution for mass greater than zero, but for the zero-mass case a solution does not exist. The localization problem is studied for zero-mass elementary systems by only imposing, as in Paper II, the above requirement of physical consistency. Systems with spin 0, ½, and 1 are considered. It is proved that the consequences are essentially the same as those obtained for systems of mass greater than zero. The parameter is no longer arbitrary. (auth)

33832 PARTICLE THEORY OF THE LAMB SHIFT WITHOUT DIVERGENCES OR CUTOFFS. Krizan, John E. (Univ. of Vermont, Burlington). Phys. Rev., D; 3: No. 10, 2333-9 (15 May 1971).

Values of the Lamb shift for the transitions 1S-2P, 2S-2P, and 3S-3P in hydrogen are compared in a nonrelativistic particle theory with no divergences or cutoffs. The theory is based on the extension of quantum-mechanical equations to the radiative case by arguing the necessity of time symmetry and the vanishing of self-interaction effects in the absence of external forces. The characteristic radiation time constant $\epsilon = Ke^2/mc^3$ is used. When K = 1, fairly good agreement for all three shifts is obtained. However, if K is adjusted to obtain the value for the 2S-2P level, the other, correspondingly adjusted levels give good agreement with the experimental values for 1S-2P and 3S-3P transitions. Vacuum polarization effects are included (for comparison with Jaynes and Crisp's results); however, these effects are probably more legitimately treated within a relativistic framework. (auth)

Gravitation and General Relativity

Refer also to abstract 33590.

33833 (JINR-P2-5738) MODIFIED SCALAR FIELD EQUATION AND CLOSED WORLD WITH FIELD SOURCES. Asanov, R. A. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. Dep. NTIS (U. S. Sales Only).

Some properties of static solutions of the Penrose equation in the presence of a point field source are considered. The exact solution of Einstein's equations (without cosmological term) in the presence of dust-like matter and Chernikov–Tagirov scalar field sources is given. The solution is the closed static isotropic world ("Einstein's world"). Results are compared with that for the ordinary scalar field equation. (auth)

33834 SEARCH FOR MICROWAVE PULSES ASSOCIATED WITH GRAVITATIONAL RADIATION. Partridge, R. B. (Princeton Univ., N. J.). Phys. Rev. Lett.; 26: 912-15(12 Apr 1971).

A microwave radiometer was used to search for pulses of radio waves from the direction of the galactic center. The results were compared with data from Weber's gravitational-wave experiment. No strong evidence was found associating microwave pulses with pulses of gravitational radiation. (auth)

33835 UPPER LIMIT ON NEUTRINO ENERGY ASSOCIATED WITH WEBER PULSES. Bahcall, John N. (California Inst. of Tech., Pasadena); Davis, Raymond Jr. Contract AT(11-1)-68. Phys. Rev. Lett.; 26: 662-3(15 Mar 1971).

An upper limit is established on the fraction of energy associated with the gravitational pulses reported by Weber that could be in the form of neutrinos with energies between 0.9 and 100 MeV. (auth)

33836 FOURTH TEST OF GENERAL RELATIVITY: NEW RADAR RESULTS. Shapiro, Irwin I. (Massachusetts Inst. of Tech., Cambridge); Ash, Michael E.; Ingalls, Richard P.; (and others). Phys. Rev. Lett.; 26: 1132-5(5 May 1971).

New radar observations yield a more stringent test of the predicted relativistic increase in echo times of radio signals sent from Earth and reflected from Mercury and Venus. These "extra" delays may be characterized by a parameter λ which is unity according to general relativity and 0.93 according to recent predictions based on a scalar-tensor theory of gravitation. It is found that λ = 1.02. The formal standard error is 0.02, but because of the possible presence of systematic errors we consider 0.05 to be a more reliable estimate of the uncertainty in the result. (auth)

33837 TWO-BODY PROBLEM IN THE LORENTZ-COVARIANT THEORY OF GRAVITATION. Fagundes, H.; Zimerman, A. H. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Nuovo Cim.; 3B: No. 1, 60-6(11 May 1971).

The two-body problem is discussed in the classical linear theory of gravitation. The results of Barker, Gupta and Heracz are extended to arbitrary spin in the framework of Weissenhoff's special-relativistic dynamics of spinning particles. (auth)

33838 SYSTEMATIC STUDY OF THE GRAVITATIONAL 4-POLE RADIATION. ENERGY–MOMENTUM AND ANGULAR MOMENTUM OF THE RADIATION. Papapetrou, A. (Univ., Paris). Ann. Inst. Henri Poincare, Sect. A; 14: No. 1, 79-95(1971). (In French).

A systematic study of the gravitational 4-pole radiation in the linear approximation is made. All terms which are effectively of the 4-pole type, after reduction by means of the conservation law of energy-momentum, are determined and the formulas for the energy-momentum and angular momentum of the corresponding radiation are established. (France)

33839 GENERAL-RELATIVISTIC TREATMENT OF SOME DENSE MASSIVE SPHERES. Krori, K. D. (Cotton Coll., Gauhati, India). Indian J. Pure Appl. Phys.; 8: 588-91(Oct 1970).

Exact solutions in general relativity were presented for some dense massive spheres. Their astrophysical implications were also pointed out. (auth)

33840 THEORY OF GRAVITATION. Rosen, Nathan (Technion-Israel Inst. of Tech., Haifa). Phys. Rev., D; 3: No. 10, 2317-19(15 May 1971).

Since there seems to exist a preferred frame of reference in the universe, determined by the large-scale distribution of matter, a theory of gravitation is considered which resembles the general theory of relativity in being based on the equivalence principle, but is without the covariance principle. This theory leads to the same results as general relativity in the three crucial tests. The formalism can be modified to take into account the solar oblateness observed by Dicke and Goldenberg. (auth)

33841 SCATTERING OF ELECTROMAGNETIC AND GRAVITATIONAL WAVES BY A STATIC GRAVITATIONAL FIELD: COMPARISON BETWEEN THE CLASSICAL (GENERAL-RELATIVISTIC) AND QUANTUM FIELD-THEORETIC RESULTS. Westervelt, Peter (Brown Univ., Providence). Phys. Rev., D; 3: No. 10, 2319-24(15 May 1971). (NYO-2262-TA-222).

The classical general-relativistic cross sections for the scattering of either an electromagnetic wave or a gravitational wave by a scalar particle are calculated and found to agree with the results of the quantized linearized field theory. (auth)

33842 DETECTION OF LONG-PERIOD GRAVITATIONAL RADIATION. Gibbons, G. W. (Cambridge Univ., Eng.). Nature (London) Phys. Sci.; 230: 113-14(29 Mar 1971).

Discrepancies have been reported previously between the relative velocity of the earth and the Mariner 6 and 7 spacecraft as calculated from the theory of orbits and as observed using measurements of Doppler shift (Nature 229: 547 (1971)), and these

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discrepancies have been tentatively interpreted as caused by long period gravitational radiation of wavelength $\approx 3.6 \times 10^{12}$ cm. The energetics of such an interpretation are discussed and it is concluded that the gravitational wave interpretation seems unlikely. (UK)

33843 GENERAL RELATIVITY FROM GAUGE INVARIANCE. Lord, Eric A. (Univ. of Durham, Eng.). Proc. Cambridge Phil. Soc.; 69: 423-42(May 1971).

The free field equations for particles with spin are invariant under a group SL(2,c) whose transformations correspond to changes of representation of the two-component spinor algebra. The generalization of the equations which extends this invariance to a gauge invariance in the Yang–Mills sense necessitates the introduction of auxiliary fields (which are also necessary to maintain Lorentz covariance). These fields can be interpreted as the potentials of a spin-2 field, just as the auxiliary fields for the charge gauge group are the potentials of a spin-1 field (electromagnetism); this spin-2 field is then self-interacting. The Bargmann–Wigner formulation of the linear spin-2 field, when modified by the proposed self-interaction, yields a nonlinear theory of a spin-2 field which is shown to be identical with Einstein's gravitational theory. With this interpretation the auxiliary fields take on an extra role of Yang–Mills field for the general coordinate transformation group—that is, they are the components of the affine connexion. (auth) (UK)

33844 SCALAR-TENSOR THEORY OF GRAVITATION IN A MODIFIED RIEMANNIAN MANIFOLD. Sen, D. K.; Dunn, K. A. (Univ. of Toronto). J. Math. Phys. (N. Y.); 12: No. 4, 578-86 (Apr 1971).

A new scalar–tensor theory of gravitation is formulated in a modified Riemannian manifold in which both the scalar and tensor fields have intrinsic geometrical significance. This is in contrast to the well-known Brans–Dicke theory where the tensor field alone is geometrized and the scalar field is alien to the geometry. The static spherically symmetric solution of the exterior field equations is worked out in detail. (auth)

33845 UPPER LIMIT ON HIGH-ENERGY NEUTRINOS FROM WEBER PULSES. Reines, F. (Univ. of California, Irvine); Kropp, W. R.; Landecker, P.; (and others). Phys. Rev. Lett.; 26: No. 23, 1451-2(7 Jun 1971).

The results from a neutrino experiment deep underground are used to set upper limits on the energy flux of muon neutrinos which might be associated with the gravitational pulses described by Weber. (auth)

33846 HORIZONS AND ANALYTIC EXTENSIONS IN STATIC TWO-DIMENSIONAL SPACE–TIMES. Godfrey, Brendan B. (Princeton Univ., N. J.). J. Math. Phys. (N. Y.); 12: No. 4, 606-11(Apr 1971).

Necessary and sufficient conditions are derived for the analytic extendability of a static two-dimensional space–time. For all allowed cases, explicit analytic extensions are determined together with their corresponding Penrose–Carter diagrams. Extensions are classified and further discussed in terms of these diagrams with special consideration given to the question of bifurcate Killing horizons. The application of these results to four-dimensional relativistic space–times is illustrated with specific examples. (auth)

33847 CLASS OF TYPE [4] PERFECT FLUID SPACE–TIMES. Oleson, M. (Univ. of Waterloo, Ont.). J. Math. Phys. (N. Y.): 12: No. 4, 666-72(Apr 1971).

The existence of gravitational fields of Petrov–Penrose type [4] in the presence of a perfect fluid is established. In particular, the general type [4] solution of the Einstein field equations with a perfect fluid as source is obtained subject to the restriction that the repeated principal null congruence of the Weyl tensor is geodesic. The line element is expressed in terms of four arbitrary functions of a single variable, and in general admits no Killing vectors. The fluid flow is irrotational, but has nonzero shear, expansion, and acceleration. The physically reasonable requirement $0 < p \leq A$, where p is the fluid pressure and A the rest energy density, is imposed, and restricts the domain of validity of the solutions to a certain extent. In addition, it is shown that the stronger condition $0 < p \leq A/3$ excludes certain of the above solutions and further restricts the domain of validity of the remaining ones. (auth)

33848 CRITERION FOR THE INSTABILITY OF A UNIFORMLY ROTATING CONFIGURATION IN GENERAL RELATIVITY. Chandrasekhar, S.; Friedman, John L. (Univ. of Chicago). Phys. Rev. Lett.; 26: 1047-50(26 Apr 1971).

Uniformly rotating configurations in general relativity are considered, and a condition is obtained that they can be quasistatically deformed without violating any of the requirements for equilibrium. This condition extends, into the domain of the rotating stars, the criterion for the onset of dynamical instability (via a neutral mode of oscillation) that occurs by radial pulsations in nonrotating stars. (auth)

Scattering Theory

Refer also to abstracts 33401, 33626, 33682, 33720, 33721, 33723, and 33737.

33849 (INP–713(Vol.2), pp 138-58) CONNECTION BETWEEN PARTICLES AND POLES OF THE S-MATRIX. Fonda, L. (Trieste Univ. (Italy). Istituto di Fisica).

A brief analysis is given for stable and unstable particle relations with poles of the S-matrix. (J.F.P.)

33850 (ITF–70-108-E) KIRKWOOD–SALSBURG EQUATIONS FOR THE COEFFICIENT FUNCTIONS OF THE SCATTERING MATRIX. Petrina, D. Ya.; Skripnik, V. I. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 15p. Dep. NTIS (U. S. Sales Only).

The equations of the Kirkwood–Salsburg type are obtained for the coefficient functions of the scattering matrix in the Euclidean region. The existence of the solutions of the equations for the coefficient functions at the infinite volume is proved for the models of the real scalar field with the bonded nonlinear Lagrangians. The analogies between the Euclidean quantum field theory and statistical mechanics are investigated. (auth)

33851 (JINR–P4-5660) LOWER BOUNDS FOR SCATTERING PARAMETERS. Zakhar'ev, B. N.; Lkhagva, O.; Niyazgulov, S. A.; Fenin, Yu. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

A theorem on lower bounds for the scattering K-matrix in reactions of the most general type (including disintegration of the system into three and more fragments) is proved. (auth)

33852 (UCRL–20272) GENERAL TREES AND GENERAL LOOPS IN THE UNITARIZATION OF THE DUAL RESONANCE MODEL. Yu, Loh-ping (California Univ., Berkeley. Lawrence Radiation Lab.). 2 Feb 1971. Contract W-7405-eng-48. 101p. Dep. NTIS.

Thesis.

A series of beautiful, elegant, "simple" and unique formulas for general tree amplitudes and general loop amplitudes in the dual resonance model is presented. In particular, new results of multiloop amplitudes with external reggeons and pure-reggeon multiloop amplitudes are derived. Various rules are given for writing down the most general tree amplitudes and loop amplitudes by simply inspecting the corresponding Feynman-like diagrams. Simple intuitive interpretations of various factors in the formulas are also discussed. (auth)

33853 FACTORIZATION OF THE N-POINT VENEZIANO AMPLITUDE. Verbetskii, Yu. G.; Gedalin, E. V. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: 645-50(Mar 1971). (In Russian).

Factorization of the multi-particle Veneziano amplitude for the given finite set of Regge trajectories is considered. It is shown that the requirement of unambiguous comparison of Regge trajectory with a block of external particles related to it is sufficient for the total factorization of the amplitude. The amplitude of the graph with one planar closed loop is calculated and the procedure of regularization of emerging integral is discussed. (auth)

33854 CONSTRUCTION OF A COMPLETE EIKONAL REPRESENTATION. Fried, H. M. (Brown Univ., Providence). Contract NYO-2262TA-230. Phys. Rev., D; 3: 2010-13(15 Apr 1971).

A construction is given of the eikonal representation for the high-energy, fixed-momentum-transfer scattering amplitude of a pair of leptons in massive-photon quantum electrodynamics. The eikonal function appears as the sum over the exchange of all possible crossed-channel connected photon–photon amplitudes. (auth)

33855 COMPLEX REGGE POLES IN THE AMATI–BERTOCCHI–FUBINI–STANGHELLINI–TONIN MULTIPERIPHERAL MODEL. Shei, Sun-sheng (Univ. of California, Berkeley). Phys. Rev., D; 3: 1962-7(15 Apr 1971).

The multiperipheral model of Amati, Bertocchi, Fubini, Stanghellini, and Tonin is used to study complex Regge poles. The trace approximation is used to solve the multiperipheral integral

equation. The equation determining complex Regge poles for the forward-scattering case is derived and explicitly solved for the locations of complex Regge poles. Their dependence on the pion mass is discussed. (auth)

33856 KINEMATIC SUPERSTRUCTURES FOR ABNORMAL COUPLINGS IN MULTIPION DUAL AMPLITUDES. Canning, Gerald P.; Jacobs, Matthew A. (Tel-Aviv Univ., Israel). Phys. Rev., D; 3: 1928-34(15 Apr 1971).

The problem of including abnormally coupled trajectories (the ω-A_2 trajectory) in the multipion dual amplitude is analyzed in detail. A procedure for analyzing kinematic superstructures for including these trajectories is presented and the appropriate three-particle vertices are discussed. As examples of constructing the "minimal" dual amplitudes, the minimal sets of superstructures are given explicitly for the 6π and 8π amplitudes. (auth)

33857 RELATION BETWEEN TWO FORMAL DEFINITIONS OF RESONANCES IN NONRELATIVISTIC SCATTERING. Verhaar, B. J. (Technische Hogeschool, Eindhoven, Netherlands). Physica; 52: 135-43(15 Mar 1971).

A formulation of the resonance problem is given, which makes clear that an intimate relation exists between two formal theories of scattering of particles with internal degrees of freedom, one proposed by Humblet and Rosenfeld, the other by Fonda and Newton. In both theories resonances correspond to poles of the S matrix as a function of a variable E, varying in a two-dimensional surface Σ in the direct product space $E_1 \otimes E_2 \otimes E_3 \ldots$, where E_1, E_2, $E_3 \ldots$ stand for the complex channel energies. The two theories differ in the choice of Σ and E. (auth)

33858 SMALL DIMENSIONLESS PARAMETER TO CHARACTERIZE MULTIPLE-POMERANCHON PHENOMENA. Abarbanel, H. D. I.; Chew, G. F.; Goldberger, M. L.; Saunders, L. M. (Princeton Univ., N. J.). Phys. Rev. Lett.; 26: 937-40(12 Apr 1971).

A small dimensionless parameter η_P associated with the triple Pomeranchon vertex, which governs both the rate of high-mass diffractive dissociation processes and the fine structure in the J-plane spectrum near $J = 1$ is described. Theoretical arguments are given that $\eta_P \lesssim 1 - \alpha_P(0)$, and a possible experiment to measure η_P is discussed. A formula for η_P, based on a multiperipheral model, shows that in such models this parameter does not vanish, and a connection of η_P with a perturbation formalism for the Pomeranchon propagator is suggested. (auth)

33859 GENERIC FEYNMAN AMPLITUDES. Speer, E. R.; Westwater, M. J. (Inst. for Advanced Study, Princeton, N. J.). Ann. Inst. Henri Poincare, Sect. A; 14: No. 1, 1-55(1971).

Certain complex parameters are introduced into a Feynman amplitude of quantum field theory to define a new function called a generic Feynman amplitude. These amplitudes have the same singularities in the invariant variables as the usual amplitudes, but with different local behavior. This behavior is investigated for singularities associated with contracted graphs of a type called normal. Some consequences of these results for the problem of characterizing the analytic behavior of the amplitudes are pointed out. (France)

33860 CONDITIONS FOR IMPROVING THE FROISSART BOUND. Mickens, R. E. (Fisk Univ., Nashville). Lett. Nuovo Cim.; 1: No. 19, 797-9(8 May 1971).

Some additional assumptions to the normal analyticity properties are made concerning the zeros and phase of the absorptive part of the scattering amplitude, which enables the Froissart bound to be improved. (L.B.S.)

33861 SOLVABLE MODEL OF MULTICHANNEL SCATTERING. Dubrovskii, G. V.; Ob'edkov, V. D. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 12-19(Aug 1970). (In Russian).

The analytical properties of S-matrix near threshold are considered with application to the interaction-model matrix with constant elements. An exact expression for multichannel S-matrix is obtained which is used for the detailed description of the two-channel problem. The conditions for the disappearance of all the partial cross sections at definite energies are given. The connection of the method considered with the one for the scattering problem by nonspherical potentials of the kind $V(\vec{r}) = f(r)\Phi(\theta, \varphi)$ is shown. (auth)

33862 THIRD VIRIAL COEFFICIENT FOR BOSE–EINSTEIN AND FERMI–DIRAC STATISTICS AND SCATTERING MATRICES. Merkur'ev, S. P. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 32-40(Aug 1970). (In Russian).

The connection between the third virial coefficient for Bose–Einstein and Fermi–Dirac statistics and the two- and three-particle S-matrixes is established. (auth)

33863 PHENOMENOLOGICAL CONSEQUENCES OF A REGGE-CUT MODEL THAT SATISFIES s–u CROSSING. Quigg, C. (State Univ. of New York, Stony Brook). Nucl. Phys.; B29: 67-76(1971).

A phenomenological amplitude for the Regge cut arising from two-Reggeon exchange is written down in a form that manifestly satisfies s-u crossing. The recipe, which is a modification of the absorptive prescription, is formulated in terms of s-channel helicity partial-wave amplitudes. Some implications for Regge-cut phenomenology are discussed. (auth)

33864 THEOREM ON INVARIANT AMPLITUDES. Guertin, Ralph F. (Yale Univ., New Haven. Univ. of California, Berkeley). J. Math. Phys. (N. Y.); 12: No. 4, 612-30(Apr 1971).

It is shown that any basis of covariant polynomials for a two-particle scattering process yields invariant amplitudes free of kinematical singularities, provided the total number of basis polynomials equals the number of spin space components of the scattering amplitude and the polynomials of each of the two parity signatures are separately linearly independent at all points where three of the particle 4-momenta are linearly independent. This result allows one to directly identify good basis sets without going through the very tedious algebra involved in comparing them to the sets of Hepp and Williams. The latter are not useful for practical applications because the spinor indices belonging to different particles are coupled and these sets do not transform into themselves under the relevant discrete symmetry operations. (auth)

33865 RELATION BETWEEN THE SINGULARITIES OF THE S MATRIX AND THE L^2 CLASS OF SOLUTIONS IN POTENTIAL THEORY. Nelson, C. A.; Rajagopal, A. K.; Shastry, C. S. (Louisiana State Univ., Baton Rouge). J. Math. Phys. (N. Y.); 12: No. 4, 737-41(Apr 1971).

It was shown that, in the case of an exponential potential, in the s-wave S matrix there exist poles that do not contribute to the completeness, even though they appear in the same part of the k plane as the bound state poles. These poles were called "redundant" poles. Subsequently, other examples of redundant poles have appeared in the literature. Recently their importance with regard to the concept of "shadow" states has been stressed. If one constructs the Green's function for the Schrödinger equation with the boundary conditions of regularity at the origin and the outgoing spherical waves at large distances, the singularities of it in the k plane completely determine the L^2 class of eigensolutions. From this Green's function, the T matrix (and hence the S matrix) is constructed explicitly. This S matrix is found to be the same as the one defined through the usual Jost solution, and it is shown that the singularities of the S matrix, besides corresponding to those appearing in the Green's function, also contain the "redundant" singularities. Thus it is shown that the wavefunctions associated with the "redundant" singularities do not belong to the L^2 class. By a careful derivation, we resolve the paradox concerning the Heisenberg identity. In the particular cases of the exponential potential and the Eckart potential, the redundant solutions correspond to the vanishing of a Wronskian pointing to the breakdown of the linear independence of the starting wavefunctions in defining the S matrix through the Jost functions. It is stressed that when singularities appear in the S matrix other than those corresponding to the bound and scattering states of the given problem, the "redundant" singularities can only be understood by a "dynamical" equation such as the Schrödinger equation. (auth)

33866 WAVE PACKET THEORY OF COULOMB SCATTERING. Dettmann, K. (Technische Hochschule, Aachen). Z. Phys.; 244: 86-93(1971).

Potential scattering in a Coulomb field is treated in a wave packet formalism. The Rutherford law is derived from the off-energy-shell Coulomb T-matrix avoiding the usual divergencies due to the long-range Coulomb potential. (auth)

33867 QUASIPOTENTIAL EQUATION CORRESPONDING TO THE RELATIVISTIC EIKONAL APPROXIMATION. Todorov, I. T. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 3: No. 10, 2351-6(15 May 1971).

A three-dimensional Lippmann–Schwinger-type equation for the elastic scattering amplitude and the corresponding homogeneous Schrödinger equation for the two-particle bound states are studied. The potential is defined as an infinite power series in the coupling constant which fits the perturbative expansion of the on-energy-shell scattering amplitude. The approximate equation obtained by keeping only the lowest-order term in the potential is local and has the following properties: (i) The scattering amplitude yields the relativistic eikonal approximation for large energies or small exchanged mass and momentum transfer; (ii) for the Coulomb problem the approximate equation is exactly

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soluble and leads to a relativistic Balmer formula including the fine-structure splitting. (auth)

33868 RESIDUE RECURRENCE RELATIONS FOR THE VENEZIANO MODEL. Adjei, S. A.; Collins, P. A.; Hartley, B. J.; Moore, R. W.; Moriarty, K. J. M. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 1: No. 20, 839-41(15 May 1971).

Residue recurrence relations are derived for the four-point amplitude in the Veneziano model. The results are extended to the N-point amplitude. (L.B.S.)

33869 REALIZABILITY OF LINEAR DIFFERENTIAL OPERATORS AND THE DISPERSIVE BEHAVIOR OF SCATTERING. Morsy, M. W.; Ata, M. S. (Atomic Energy Establishment, Cairo). Atomkernenergie; 17: 203-8(May 1971).

An attempt is made to investigate, by using a simple formal procedure, the Sturm–Liouville second-order differential operator, which is generally proved not to be Hermitean. However, it was shown that on adding boundary terms Hermiticity can be achieved. During the course of the work it was found necessarily to have a new set of "right-handed differential and integral operators", in addition to the conventional left-handed ones. This remark has a very interesting consequence, which may imply the existence of a "mirror" in the mathematical space. It is next shown how the methods of realizing non-Hermitean operators are used not only to avoid pitfalls which may occur in the quantal description of resonance scattering but also to establish a new version of dispersion relation. This dispersion relation is extremely general, so that the Kapur–Peierls and Wigner–Eisenbud formalisms may be obtained by appropriate specialization. (auth)

33870 PHYSICAL STATES IN DUAL-RESONANCE MODELS. Di Vecchia, P.; Fubini, S. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Lett. Nuovo Cim.; 1: No. 20, 823-7(15 May 1971).

A rule is given for the construction of vertex operators associated with physical states coupled to two ground particles, which allows the evaluation of N-point amplitudes. The procedure shows the degeneracy of the spectrum in the dual-resonance model and its dependence on the number of external legs. (L.B.S.)

33871 POLARIZATION AND COMPLEX CONJUGATE POMERANCHUK TRAJECTORIES. Chylek, P. (Indiana Univ., Bloomington). Lett. Nuovo Cim.; 1: No. 20, 828-30(15 May 1971).

Previous investigations of the asymptotic ratio of the polarization in particle–particle and particle–antiparticle scattering led to the result that at asymptotic energy the particle–antiparticle polarization should be equal in magnitude but opposite in sign to the particle–particle polarization. It is shown that this result is not necessarily true if the amplitude is dominated by a pair of complex conjugate Regge poles. (L.B.S.)

33872 HIGH-ENERGY POTENTIAL SCATTERING. II. Cheng, Hung; Wu, Tai Tsun (Massachusetts Inst. of Tech., Cambridge. Deutsches Elektronen-Synchrotron, Hamburg). Contract AT(30-1)-4101. Phys. Rev., D; 3: No. 10, 2397-2410 (15 May 1971).

In view of the advances of knowledge, both experimental and theoretical, about hadronic scattering processes at high energies, the potential-theory model studied before is found to exhibit a number of realistic features. Because partial differential equations can be dealt with in a much more straightforward manner than operator equations, this potential-theory model is useful in understanding some features of high-energy processes. The problem of exponentiation, i.e., the possible appearance of an exponential factor, is studied in detail. It is found that the simple-exponentiation form, found recently in field theories within certain approximations, does not hold in general when the scattering particles have a finite size or internal degrees of freedom. This result in turn is applied to the field-theoretical cases to understand further the nature of the approximations involved. (auth)

33873 CALCULATIONS OF THREE-PARTICLE SCATTERING AMPLITUDES USING LOCAL YUKAWA POTENTIALS. Pieper, S. C. (Univ. of Illinois, Urbana); Schlessinger, L. Phys. Rev., D; 3: No. 10, 2419-24(15 May 1971).

Calculations of three-particle phase shifts for a system interacting via local Yukawa potentials are presented. The method involves numerical analytic continuation from the bound-state region to the scattering region. The method is also applied to separable potentials to verify that it in fact gives correct results. (auth)

33874 SOME CONSTRAINTS ON PARTIAL WAVES OF HELICITY AMPLITUDES WHICH FOLLOW FROM ANALYTICITY, UNITARITY, AND CROSSING SYMMETRY. Case, William (Syracuse Univ., N. Y.). Phys. Rev., D; 3: No. 10, 2472-7(15 May 1971).

Some inequalities involving finite numbers of partial-wave helicity amplitudes are derived for the elastic scattering process ab → ab (arbitrary spins and masses). One set of inequalities involves algebraic combinations of t-channel ($a\bar{a} \to b\bar{b}$) partial-wave helicity amplitudes and holds for any value of t between 0 and $4\mu^2$ (μ is the lesser mass of the two particles involved in the scattering). A second set places restrictions on integrals over s-channel (ab → ab) partial-wave helicity amplitudes. Finally, the above relations are applied to the particular case of π^0-nucleon elastic scattering, where inequalities among partial-wave helicity amplitudes are obtained. (auth)

33875 LOOP DIAGRAMS IN DUAL-RESONANCE THEORIES WITH NONLINEAR TRAJECTORIES. Baker, M. (Univ. of Washington, Seattle); Coon, D. D. Contracts AT(45-1)-1388; AT(11-1)-1764. Phys. Rev., D; 3: No. 10, 2478-85(15 May 1971).

Rules are presented for calculating loop diagrams in a dual-resonance theory with nonlinear trajectories. Explicit expressions for the self-energy graph, the vacuum bubble graph, and the vertex graph are given. In the limit of linear trajectories the integrands of these graphs diverge. This is in contrast to the behavior of the tree graphs which approach the Veneziano tree graphs in the same linear limit. It is also shown that when the trajectories are nonlinear, the self-energy graph including the $\int d^4k$ is finite. It should be emphasized that these rules have been developed without consideration of the factorization properties of the non-linear N-point Born term. In this sense they are analogous to the original Veneziano-loop-diagram rules of Kikkawa, Sakita, and Virasoro, which were subsequently modified by the requirements of factorization. However, although our rules may likewise be modified, they present a simplified context for developing techniques which are of general value for the study of the nonlinear theory. (auth)

33876 GENERALIZED UNITARITY AND FIXED J-PLANE POLES. Squires, Euan J. (Univ. of Durham, Eng.) Phys. Rev., D; 3: No. 10, 2527-8(15 May 1971).

It is shown that generalized unitarity rules out some of the fixed J-plane poles recently introduced by Finkler. (auth)

33877 REMARKS ON A TEST OF THE PADE-APPROXIMANT APPROACH IN THE COULOMB BOUND-STATE PROBLEM. Gammel, J. L.; Menzel, M. T. (Univ. of California, Los Alamos, N. Mex.). Phys. Rev., D; 3: No. 10, 2528-9(15 May 1971).

An integral occurring in a paper by Crater with the same title is calculated exactly by numerical methods in order to further test the conclusions of that paper. (auth)

33878 MULTILINEAR LORENTZ-INVARIANT FUNCTIONALS AT THE PHYSICAL POINTS. Montvay, I. (Roland Eoetvoes Univ., Budapest). Phys. Rev., D; 3: No. 10, 2532-3(15 May 1971).

The "fully Reggeized scattering amplitudes" of Domokos, Kovesi–Domokos, and Schonberg are investigated near the physical points and another regularization is proposed. (auth)

33879 t = 0 KINEMATICAL CONSTRAINTS AND EXCHANGE OF QUANTUM NUMBERS IN ELASTIC SCATTERING. Lam, W. S. (Ecole Polytechnique, Paris). Phys. Rev., D; 3: No. 10, 2534-5 (15 May 1971).

By using the kinematical constraint at t = 0 and crossing relations, it is shown that for two-body elastic scattering of particles with any spin in the forward direction, the s-channel helicity-conserving amplitudes are due only to PC = +1 t-channel contributions, and for any nonvanishing s-channel helicity-nonconserving amplitudes, the PC = +1 and the PC = –1 t-channel contributions are equal to each other. (auth)

33880 SOLUBLE THREE-PARTICLE SCATTERING PROBLEM. Dodd, L. R. (Univ. of Adelaide). Phys. Rev., D; 3: No. 10, 2536-8(15 May 1971).

A three-particle scattering model, of the type discussed by Brayshaw and Peierls, is solved exactly. (auth)

33881 COLLIDING REGGE POLES AND COMPLEX CUTS. Picciotto, Charles (Univ. of Victoria, B. C.). Phys. Rev., D; 3: No. 10, 2538-40(15 May 1971).

The model developed recently by Kaus and Zachariasen for collisions between real l cuts and poles is extended to the case of complex l cuts. It is found that the method lends itself readily to this generalization. Some consequences are discussed; in particular, the model allows for trajectories of constant real part around s = 0, which is of interest for the description of diffraction scattering. (auth)

Particle Accelerators

Refer also to abstracts 32253, 32306, 32469, 33200, 33535, and 33641.

33882 (ANL-Trans-876) MULTICHARGED ION SOURCES. Vorob'ev, E. D.; Pasyuk, A. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). Translated for Argonne National Lab., Ill., from report JINR-P7-5177. 28p. (CONF-700555-1). Dep. NTIS.

From fourteenth all union conference on emission electronics; Tashkent, USSR (May 1970).

A survey of the development of multicharged heavy-ion sources is presented. Heavy ions may be produced by an arc discharge, electron bombardment under an ultrahigh vacuum, the interaction of a laser beam with the surface of a solid or with a gas, or by a high-power spark discharge. The design and operation of various sources are described and performance data are presented. 39 references. (W.H.K.)

33883 (BNL-15792) 1000-GeV STORAGE RINGS. II. Blewett, John P. (Brookhaven National Lab., Upton, N. Y.). 7 Apr 1971. 11p. Dep. NTIS.

A lattice is proposed for storage rings of very high energy using superconducting magnets. Two intersecting rings run adjacent to each other and can be contained in a single dewar system. Solutions to the problem of operation of adjacent air-core dipoles are presented. (auth)

33884 (CERN-71-9) SOME ASPECTS OF THE MAIN RECTIFIERS FOR THE ISR MAGNETS. Etgen, O., Groenenboom, M.; Lisser, J.; van der Meer, S. (European Organization for Nuclear Research, Geneva (Switzerland)). 4 Mar 1971. 25p. Dep. NTIS (U. S. Sales Only).

The magnets of the intersecting storage rings are fed by two 6.9 MW stabilized rectifiers, each supplying a maximum of 3750 A at 1850 V. After a short general description, aspects of these rectifiers that are new or non-standard are described. The most important of these are: a passive filter with a current limiter that combines some advantages of damped and undamped filters; a relatively small active filter of the parallel-connected type that reduces the voltage ripple to less than 100 mV; and an unusual thyristor gate control system, designed to combine fast, linear response with a minimum amount of subharmonics generated by firing inaccuracy. (auth)

33885 (CONF-700341-4) APPLICATION OF SUPERCONDUCTORS IN MICROWAVE TECHNIQUES: OSCILLATORS, PARTICLE ACCELERATORS. Septier, A. (Centre National de la Recherche Scientifique, Paris (France). Paris Univ., Orsay (France). Faculte des Sciences). 1970. 13p. (In French). Dep. NTIS (U. S. Sales Only).

From Panel on superconductors; Paris, France (17 Mar 1970).

A brief description of the characteristics of the impedance of the surface of metals and superconductors at low temperature is given. The performances of superconductors in the microwave cavity techniques used with particle accelerators or in the development of oscillators are examined. The results obtained with a loop oscillator, a monotron oscillator, and a tunnel diode oscillator are described. Possible applications of the Josephson effect in the generation of UHF waves are considered. (France)

33886 (INS-TH-66) CALIBRATION OF BEAM MONITORS. Akino, Yoshio; Ukai, Kumataro; Okuno, Hideki; Kabe, Seiji; Kasuya, Masaaki (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jul 1970. 20p. (In Japanese). Dep. NTIS (U. S. Sales Only).

The calibration constants of a quantameter (QM) and a thick-walled ion chamber (TC), their energy dependence, and the charge loss due to ionic bond are presented. The total energy U of the gamma-ray which enters the QM or the TC and the charge q generated in the QM or the TC have the following relation, $U = Uq \times q$ where Uq is the calibration constant of the QM or the TC. The electron beam from an electron synchrotron produced gamma-ray due to bremsstrahlung, and the gamma-ray irradiated the QM or the TC in a laboratory. The electron beam was monitored by a secondary electron monitor (SEM) which was calibrated with a Faraday cup (FC). The amount of charge integrated in the SEM, QM, TC and FC was measured with Lewis and Collinge type current integrators. Two aluminum plates (597 u and 209 u thick) were used for the conversion of electrons to gamma-ray. The conversion rate f(E) was approximately as follows, $f(E) = \Delta t/t$ where Δt is the thickness of the converter, and t is the thickness per 1 radiation length, and a function of the energy of incident electrons. The bias voltage of the QM and the TC were 270V and 1000V, respectively. The result of the measurement of the calibration constants of the QMs was $(4.62 \pm 0.14) \times 10^{18}$ MeV/coulomb for the first QM, and $(4.69 \pm 0.14) \times 10^{18}$ MeV/coulomb for the second QM. No energy dependence was observed for the calibration constant of the QM. The calibration constant of the TC varied slowly with energy. Radial response was measured. The charge loss due to ionic bond was negligible when the output current of the TC was 10^{-7}A. The loss in the QM was less than that in the TC. (KATO, T)

33887 (INS-TL-107) PDP-9 PROGRAMS FOR INS FM ANALYZER. I. FMMASZ, FMMAEZ, FMMACZ, FMANLZ, AND FMMASQ. Kokame, Jun (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Dec 1970. 16p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

The Institute for Nuclear Study of Tokyo University has provided programs for a PDP-9 computer to perform various experiments with a FM cyclotron beam analyzer. These programs have been used so widely and frequently that their function, constitution, usage, and contents are described for the purpose of providing reference for those who intend to use them or to develop new programs. The programs FMMASZ, FMMAEZ, FMMACZ, FMANLZ, and FMMASQ are described. Also, precautions for program loading and usage, constitution, flow charts, and contents of the programs are described. (Japan)

33888 (INS-TL-108) PDP-9 PROGRAMS FOR INS FM ANALYZER. II. QVSPAC AND QVCSPA. Kokame, Jun (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Dec 1970. 11p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

The programs QVSPAC and QVCSPA are written for a PDP-9 computer for computing the excitation energy of residual nuclei (QX value) corresponding to the peak value in the momentum spectrum measured with a 200-run proportional counter of a FM cyclotron analyzer. The programs can compute energy loss of incident and emitted particles in a target so that the Q value is calculated with correction for these effects. However, the programs can compute Q values only for those targets of simple substances or two-element compounds, and can neither handle more complex targets nor correct the energy loss within the backing. This is due to the limitation on memory capacity. The function, usage, contents and constitution of the programs are described. Flow charts and a typical FORTRAN program are shown as examples. (Japan)

33889 (INS-TL-109) PDP-9 PROGRAMS FOR INS FM ANALYZER. III. CKSPAO. Kokame, Jun (Tokyo Univ. (Japan). Inst. for Nuclear Study). 1 Dec 1970. 22p. (In Japanese and English). Dep. NTIS (U. S. Sales Only).

Institute for Nuclear Study has provided a series of programs for a PDP-9 computer to perform various experiments with a FM cyclotron analyzer. The program CKSPAO is one of the programs, and was developed to easily detect the direction of the incident beam which travels through the center of a target or the center axis of a scattering tank. The program utilizes the fact that the energy level of particles scattered elastically varies with the angle of the laboratory system, so that the measurement may be performed in one direction either on the plus or minus side of the beam. The usage, contents, constitution, and measurement errors of the program are described. Typical flow charts and the FORTRAN program are shown in the appendix. (Japan)

33890 (JINR-P13-5699) MULTIPLEX TARGET. Soroko, L. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1971. 7p. (In Russian). Dep. NTIS.

The multiplex Hadamard-transform target designed to measure the angular distribution of particles in the presence of large background in the experimental hall is described. The gain in the effective signal-to-background ratio achieved by this multiplex target is the result of spatial multiplexing, that is, of coding the angular distribution to be measured before counting it. The multiplex target has a multi-element heterogene structure, which permits the measurement of particles at several angles simultaneously by the integral coding algorithm. The transform code is the cyclic trans-orthogonal Hadamard code. The angular distribution of particles to be measured can be found at the second stage by decoding transformation with the same code, as was used on the stage of primary coding. (auth)

33891 (KFK-1220) ARRANGEMENT FOR AUTOMATIC MAGNETIC FIELD MEASUREMENTS. Brandes, J.; Friesinger, G.; Ulbricht, A. (Kernforschungszentrum, Karlsruhe (West Germany)). May 1970. 12p. (CONF-700503-10). Dep. NTIS (U. S. Sales Only).

From third international conference on magnet technology; Hamburg, Germany (19 May 1970).

An arrangement for automatic magnetic field measurements is developed. It can be used for bending, quadrupole, and gradient

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magnets with field strengths up to 50 kG within 0.1% and assists the development of synchrotron and beam transport magnets. The measurement is done with Hall probes, coils or resistors. The magnetic field sensors are positioned by a specially constructed measuring machine within ±10 μm. All slide bearings are static air bearings to avoid stick slip and wear and tear. For automatic acquisition of the high quantities of data and for on-line control of the measurements, the measuring system is connected to a TR 86 computer. (auth)

33892 (LYCEN-7103) THE INTERDIGITAL STRUCTURE: THEORETICAL INTERPRETATION TEST AND PRINCIPAL CONTROLS FOR PRACTICAL OPERATION. Bres, Michel (Lyon Univ. (France). Institut de Physique Nucleaire). Feb 1971. 55p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The research was carried out in the framework of a project for a heavy ion accelerator reaching 10 MeV per nucleon. The phase shift in an interdigital structure of the H type was studied using a ladder model of filter sections. A good qualitative explanation of the phenomenon was obtained from a theoretical study. A device allowing the resonance frequency of the cavity to be varied was studied experimentally and theoretically. The device was used to vary the accelerating electric field. (auth)

33893 (NAL-57) MONTHLY REPORT OF ACTIVITIES, APRIL 30, 1971. Cole, F. T. (National Accelerator Lab., Batavia, Ill.). Contract AT(49-8)-3000. 13p. Dep. NTIS.

Progress on the main accelerator, booster, linac, rf system, beam transfer system, and experimental facilities are outlined. (W.H.K.)

33894 (NP-18786) CONTRIBUTION TO THE STUDY OF ELECTROSTATIC SEPARATION OF HIGH-ENERGY PARTICLES: TWO PLATE AND MULTIPLE-PLATE SEPARATORS. Simon, D. J. (Rennes Univ. (France). Faculte des Sciences). 1971. 146p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

Two very different methods for the separation of high-energy particles by means of deflectors with crossed electric and magnetic fields are considered. The study was focused on two-plate electrostatic separators and multiple-plate electrostatic separators. The action of the two-plate separator on the trajectory of the particles crossing it is summarized. The behavior of the beam in its entirety is studied by taking into consideration the individual trajectories of the particles using the concept of track space. The optima of the principal parameters of the system were determined as a function of the incident beam geometry. Although the behavior of particles in each cell of the multiple-plate separator is the same as in the two-plate separator, the problem is complicated because of the scattering of particles rejected by the numerous plates of the system. The transmission of the particles desired and the contamination due to the Coulomb scattering of the beam particles which touch the plates were studied simultaneously. The representations in the track space were used to study the optical performances of the two types of separators. The two types of separators were compared on the basis of the high voltage performance obtained with the test separators. The applications and limitations of the two types of separators are discussed. (tr-auth)

33895 (NP-18839) STUDY AND DEVELOPMENT OF AN INDUCTION MEASURING DEVICE FOR THE ORSAY SYNCHROCYCLOTRON. Hage-Ali, Makram (Paris Univ., Orsay (France). Faculte des Sciences). 1971. 42p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The development of a device for measuring the induction produced by a beam of accelerated particles is discussed. The apparatus is described (supermalloy tori, a sensitive amplifier, and electronic sampling equipment). An accuracy of about 2% was obtained for mean currents in excess of 3.10^{-10} amperes in a normally operating synchrocyclotron. The minimum detectable beam flux is 2.10^9 protons per second i.e. 4.10^6 protons per 20 microsecond pulse. A good stability is obtained provided the synchronization signal of the synchrocyclotron remains in phase with the extracted beam. (France)

33896 (NP-tr-1933) CALCULATION OF THE INTERNAL STRUCTURE OF THE INTENSE FLUX OF CHARGED PARTICLES HAVING A NONLAMINAR AXIALLY SYMMETRIC STRUCTURE. Kuznetsov, V. S.; Bogdanova, V. I.; Komarov, O. L. ([Scientific Research Inst. of Electro-Physical Apparatus, Leningrad (USSR)]). Translation of a Russian paper. 27p. (In French). Dep. NTIS (U. S. Sales Only).

A statistical method was used to calculate the nonlaminar beam. A system of equations describing the internal structure of the nonlaminar beam of charged particles is derived. A nonlaminar beam model with non-zero angular velocities is considered and it is shown that this model describes the properties of the actual beams much better than the nonlaminar models with zero angular velocity. The calculated results of the internal structure of an intense nonlaminar beam, focused by homogeneous longitudinal magnetic fields, are given. (tr-auth)

33897 (NP-tr-1934) USE OF HF QUADRUPOLAR FOCUSING IN ION LINEAR ACCELERATORS. Teplyakov, V. A. ([Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii]). Translation of a Russian paper. 19p. (In French). Dep. NTIS (U. S. Sales Only).

The use of HF quadrupolar focusing in proton linear accelerators is examined theoretically considering the single interval, variants of HF focusing, basic relations, the electrodes, the initial part of the accelerator, and the H cavity. The possible parameters of a proton linear accelerator using HF focusing by a quadrupolar field are tabulated on the basis of theoretical considerations. (J.S.R.)

33898 (ORNL-TM-3391) HIGH PERFORMANCE HEAVY-ION SOURCE FOR CYCLOTRONS. Hudson, E. D.; Mallory, M. L.; Mosko, S. W. (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 9p. (CONF-710308-22). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

A cold cathode Penning discharge ion source,[1,2] power supply, and its performance in the Oak Ridge Isochronous Cyclotron (ORIC) are described. The ion source has operated at power levels as high as 8 kW and has produced a variety of particle beams, ranging from deuterium to xenon and with charge states up to +12. In particular, 20 eμA (electrical microampere) of $^{16,18}O^{5+}$, 5×10^4 p/sec (particle per second) of $^{40}Ar^{10+}$, and 10^7 p/sec of $^{132}Xe^{12+}$ have been extracted from ORIC. From the known intensities of accelerated ions and the calculated total ionization potential, a means of predicting particle intensity for a given charge state has been developed. (auth)

33899 (RPP/N-23) A SUPERCONDUCTING SYNCHROTRON DESIGN STUDY AT THE RUTHERFORD LABORATORY. Donald, M. H. R.; Harold, M. R.; King, N. M.; Loach, B. G.; Maidment, J. R. M.; Planner, C. W.; Rees, G. H.; Trotman, J. V. (Rutherford High Energy Lab., Chilton (England)). Feb 1971. 13p. (CONF-710308-20). Dep. NTIS (U. S. Sales Only).

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

Design features of a superconducting synchrotron to replace Nimrod are outlined. Constraints imposed by existing accelerator buildings and plant determine many of the parameters. The separated-function doublet lattice has 20 focusing periods, with 4 long straight sections created by omitting bending magnets from the appropriate periods. (auth)

33900 (SLAC-Trans-131) COUPLING AND DECOUPLING OF BETATRON OSCILLATIONS BY LONGITUDINAL MAGNETIC FIELDS, WITH APPLICATIONS TO THE LONGITUDINAL DETECTOR FIELD IN A STORAGE RING. Ripken, Gerhard. Translated by I. M. R. Jones for Stanford Linear Accelerator Center, Calif., from Ueber die Kopplung und Entkopplung der Betatronschwingungen durch Longitudinale Magnetfelder mit Anwendungen auf das Longitudinale Detektorfeld im Storage-Ring. 11p. Dep. NTIS.

It is shown that with any field shape the betatron-oscillation coupling caused by the longitudinal detector field can be exactly reversed by longitudinal compensating fields if the path integral over the longitudinal component of the total field vanishes. This is proved by switching to an appropriate coordinate system rotated about the s-axis, in which the betatron oscillations are decoupled. Condition equations for the Q shift and for the closed-orbit shift that occurs with a finite angle of intersection are given within the framework of the linear machine theory developed by Courant, Livingstone and Snyder. (auth)

33901 (UARAEE-51) DESIGN AND CONSTRUCTION OF A MILLIMICROSECOND PULSING APPARATUS FOR A 2.5 MV VAN DE GRAAFF ACCELERATOR. Moustafa, A.; Abdelaziz, M. E.; Badawy, I. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1968. 22p. Dep. NTIS (U. S. Sales Only).

A millimicrosecond ion-beam pulsing apparatus has been designed to suit the specific conditions of the 2.5 MV Van de Graaff accelerator of the Atomic Energy Establishment of U.A.R. The apparatus is intended for the studies of fast-neutron

time-of-flight and the applications. The apparatus is a post-acceleration deflector plate sweeping system. It utilizes a pair of deflector plates driven by a RF potential of 2 KV peak voltage alternating at 4 MC/S, and a pair of refractor plates which operates with dc field for alternate-pulse elimination. Pulsed protons, deuterons, and helium ion beams can be produced. Measurements are taken for ion-burst duration by a γ-RF delayed coincidence system where pulsed protons in the range of 1 to 2.5 MeV are allowed to bombard an aluminium target and the γ-RF coincidences are recorded. Bursts of protons of 17 to 43 ns have been achieved. (auth)

33902 (UARAEE-77) EFFECT OF FRINGING FIELDS ON THE ION BURST DURATION IN A PARALLEL PLATE PULSER. Moustafa, A.; Abdelaziz, M. E.; Badawy, I. I. (Atomic Energy Establishment, Cairo (Egypt). Dept. of Accelerators and Plasma Physics Research). 1969. 16p. Dep. NTIS (U. S. Sales Only).

In a parallel plate pulser for the production of millimicrosecond pulsed ion beams, the beam is swept across an aperture by the effect of the electrostatic field due to the rf potential imposed on the plates. Theoretical analysis for the deflector plate sweeping method is discussed. The effects of the fringing fields at the deflector plate ends are studied. It is shown that the fringing fields at the plate ends act as though the plate length were extended by an amount directly proportional to the deflector plate spacing. This would give relatively shorter ion burst durations at the defining aperture. (auth)

33903 (UCRL-20171) RESIDUAL FIELDS IN SUPERCONDUCTING DIPOLE AND QUADRUPOLE MAGNETS. Green, Michael A. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 11p. (CONF-710308-24). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1Mar 1971).

The magnetic measurements of residual fields in superconducting dipole and quadrupole magnets are discussed. The technique used to measure residual fields is described. The results of the measurement are presented and compared with a simplified theory, which predicts the basic nature of residual fields. The theory and experiment agree reasonably well despite the simplifying assumptions made in the theory. The residual fields generated in a superconducting magnet do affect the uniformity of the field generated in such a magnet. The effects of residual fields are worst at low fields, which is precisely where one wants the most magnet uniformity in a superconducting synchrotron. The theory suggests that one can reduce the magnitude by: (1) reducing the strand diameter in the material (smaller strands require more twist to eliminate coupling); and (2) reducing the low-field critical current of the material, which also reduces ac loss and instabilities. The theory also suggests that superconducting synchrotrons with injection inductions as low as 1 kG must have superconductor strands as small as 1 to 2 μm. (auth)

33904 (UCRL-20179) PCM TELEMETRY SYSTEM FOR 3-MV SUPERHILAC INJECTOR. Reginato, L. L.; Dobeck, N. J.; Smith, B. H. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 2p. (CONF-710308-21). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

A time-division multiplex communications system using pulse code modulation (PCM) has been built for the new 3-MV Super-Hilac injector. Transmission between the high-voltage terminal and ground uses light beams generated by light-emitting diodes and is received by photodiodes. With each accelerator pulse a sequence of 384 time slots is transmitted—each defined by a clock pulse transmitted over an adjacent light beam. Binary information is then conveyed by the presence or absence of pulses in the appropriate time slots. This system can handle, in either direction, 16 parallel analog input channels which are encoded into 16 12-bit binary coded decimal (BCD) serial words and 192 parallel "ON-OFF" input channels which are also encoded into 16 12-bit serial words. Thus a serial transmission in either direction consists of 32 12-bit words. (auth)

33905 (UCRL-20183) RECENT EXPERIMENTS ON FORMING ELECTRON RINGS AT BERKELEY. Lambertson, G. R.; Keefe, D.; Laslett, L. J.; Perkins, W. A.; Peterson, J. M.; Rechen, J. B. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 4p. (CONF-710308-27). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

In the initial electron-ring experiments with a new high-current, 2 MeV electron injector, an efficient method of trapping of the injected beam was developed and a suitable compression cycle was found in which betatron amplitude growth on single-particle resonances is negligible. The ring behavior is satisfactory during the compression cycle at low intensity ($N_e < 5 \times 10^{11}$). At higher intensities the lowest mode of the coherent radial instability appeared, but the threshold for its onset was raised considerably by increasing the Landau damping coefficient, so that it is no longer the limiting instability. At intensities $N_e > 10^{12}$ electrons, a longitudinal (negative mass) instability causes particle loss and radial spreading of the electron rings. Increasing the energy spread in the beam has raised the threshold for several phenomena observed in connection with this instability. The effects of changing the electromagnetic environment of the electron rings to suppress this instability are being investigated. (auth)

33906 (UCRL-20184) END EFFECTS IN SUPERCONDUCTING BEAM-TRANSPORT MAGNETS. Meuser, Robert B. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 4p. (CONF-710308-28). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

Superconducting dipole or multipole magnets which provide magnetic fields transverse to the axis of a right circular cylinder for beam transport are considered. The integral theorem criterion for judging the quality of a magnet is outlined, and several configurations for reducing the aberrations at the ends of magnets are described and discussed. (W.H.K.)

33907 (UCRL-20188) SUPERCONDUCTING PULSED SYNCHROTRON DIPOLE AND DC BEAM TRANSPORT MAGNETS. Eaton, W. F.; Gilbert, W. S.; Kilpatrick, R. A.; Meuser, R. B.; Toby, F. L.; Voelker, F. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 4p. (CONF-710308-25). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

Pulsed dipoles for superconducting synchrotron application have been built and tested. Low cyclic loss up to a central dipole field of 23 kG has been demonstrated. A large dc dipole transport element for the Bevatron area use has been built and tested; the warm bore aperture is 8 in. and the design central field is 42 kG. Details of this magnet and a companion quadrupole doublet are given. (auth)

33908 (UCRL-20249) BEVATRON OPERATION AND DEVELOPMENT. 65, JANUARY THROUGH MARCH 1970. Crebbin, Kenneth C.; Frias, Robert (California Univ., Berkeley. Lawrence Radiation Lab.). 12 Jan 1971. Contract W-7405-eng-48. 14p. Dep. NTIS.

The Bevatron resumed operation January 6, 1970 after a six-week shutdown. A new septum beam split was installed in the F1 Channel I region. Details of the operation and backstop region of the new beam are discussed. The Bevatron operated for high energy physics 82.6% of the scheduled operating time and accelerated 2.9×10^{18} protons during the first quarter of 1970. Nine new experiments were started. Pulse-to-pulse stability of the main magnet motor-generator sets is discussed. (auth)

33909 (UCRL-20605) SESSION I: CRYOGENIC MAGNETS AND SYNCHROTRONS, CRYOGENIC AND VACUUM TECHNOLOGIES. PANEL DISCUSSION ON SUPERCONDUCTING SYNCHROTRONS. Gilbert, William S. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 7p. (CONF-710308-23). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

Some recent developments in pulse dipole magnets for superconducting proton synchrotrons are outlined. Fine wire developments, model pulse dipole results, and cost estimates are discussed. (W.H.K.)

33910 (UCRL-20607) BEAM-SURROUNDING INTERACTIONS AND THE STABILITY OF RELATIVISTIC PARTICLE BEAMS. Sessler, Andrew M. (California Univ., Berkeley. Lawrence Radiation Lab.). Feb 1971. Contract W-7405-eng-48. 6p. (CONF-710308-11). Dep. NTIS.

From National particle accelerator conference; Chicago, Ill. (1 Mar 1971).

A review on the interaction of a relativistic particle beam with itself which is a result of the coupling of the beam with its surroundings is presented. The static self-field phenomena including transverse oscillations, longitudinal oscillations, and the bunch length in electron storage rings are discussed. Also, the dynamic self-field phenomena, particularly the coherent longitudinal

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instability of a uniform beam, are reviewed. 35 references. (W.H.K.)

33911 (UCRL-Trans-1435) RADIATION EFFECTS IN THE DYNAMICS OF RELATIVISTIC ELECTRON RINGS. Kolomenskii, A. A. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated by G. Brodell for Univ. of California Lawrence Radiation Lab., Berkeley, from Preprint LEBEDEV-70-155. 28p. Dep. NTIS.

The effects of synchrotron radiation from electrons in compressors for electron-ring accelerators are evaluated. The equations of motion with relativistic radiation of electrons in a magnetic system, the equilibrium motion of the radiating electron in the induction condition, the nonequilibrium motion of the radiating electron, and the application of the results obtained to the dynamics of the electron ring are studied. (W.H.K.)

33912 POLARIZED ION SOURCE. Wakuta, Yoshihisa; Hasuyama, Hiroki; Tsuji, Katsuhiko; Sonoda, Masateru; Katase, Akira (Kyushu Univ., Fukuoka). Jap. J. Appl. Phys.; 10: 662-3(May 1971).

A polarized deuteron source based on the atomic beam principle with a strong field ionizer is described. The tensor polarization of the deuteron beam is analyzed by measuring the anisotropy factor of the T(d,n) reaction. (W.H.K.)

33913 METHOD AND APPARATUS FOR ENHANCEMENT OF NUCLEAR POLARIZATION BY OPTICAL PUMPING IN SOLIDS AND LIQUIDS. Jeffries, Carson D.; Mollenauer, Linn F. (to United States Atomic Energy Commission). U. S. Patent 3,546,575. 8 Dec 1970. Filed 30 Oct 1968.

A means for producing sizable nuclear polarizations in normal-density matter at both room and low temperatures is described. By irradiating a crystal with circularly polarized light in combination with preferential relaxation and microwave resonance, enhancement is obtained of the polarizations of nuclei in hyperfine interaction with paramagnetic ions as well as of abundant nuclei at diamagnetic sites throughout the crystal. (auth)

33914 PRECISION BEAM LOCATION. Sickafus, E. N. (Ford Motor Co., Dearborn, Mich.). Rev. Sci. Instrum.; 42: 640-3(May 1971).

A method for precise positioning of a beam on a given target is described. The technique employs a time dependent bias applied to the relative target beam position and frequency tuned detection of an associated flux that is coherently sensitive to changes in the primary beam. A location reference is determined which is the centroid of the convolution product of the target shape function and the beam profile function. (auth)

33915 DIAGNOSTICS OF ELECTRON–ION CLUSTERS BY MEANS OF BREMSSTRAHLUNG. Iovnovich, M. L.; Sarantsev, V. P.; Fiks, M. M. At. Energ. (USSR); 29: 465-7(Dec 1970).

The method for collective ion accumulation based on electron–ion cluster acceleration by external electromagnetic fields was previously suggested by V. I. Veksler et al. (Atom. Energ. 24, 317, 1968). In the external field a cluster was formed by a thin ring of relativistic electrons (with large radius R and small radius a) in which the accumulation took place. During the accumulation, collisions between electrons, atoms, and ions produced an electron bremsstrahlung which the authors used for diagnostics of the cluster. The results showed that such diagnostics determined the total number of electrons in the ring on the basis of data for the initial concentration of heavy particles. (R.V.J.)

33916 CHARGED-PARTICLE FOCUSING BY A HOMOGENEOUS MAGNETIC FIELD WITH CORRECTIONS FOR THE ENTRANCE BOUNDARY. Zarubin, P. P.; Padalko, V. Yu.; Khrisanfov, Yu. V. Vestn. Leningrad. Univ., No. 16, Fiz., Khim.; No. 3, 41-8(Aug 1970). (In Russian).

Focusing properties of the two sector homogeneous magnetic field are considered. The boundaries of the sectors are straight lines and the sectors are close to each other. One of the variants of broad-range magnetic spectrographs is calculated. The performances of some spectrographs are compared. (auth)

33917 EQUILIBRIUM LENGTH OF HIGH-CURRENT BUNCHES IN ELECTRON STORAGE RINGS. Pellegrini, C.; Sessler, A. M. (Univ. of California, Berkeley). Nuovo Cim.; 3A: 116-34(1 May 1971).

An equilibrium theory of the length of intense electron bunches circulating in a storage ring is presented. The consequence of electrical interaction with various resonant structures is expressed in terms of quadratures over the impedance of the structures and impedance functions for a variety of elements are evaluated. It is shown that elements having resonances at high frequency can, above transition, cause bunches to increase in length with increasing current. The parametric dependence of the bunch lengthening is found to be in good agreement with observations, and numerical estimates, which are in substantial agreement with experiment, are presented. (auth)

33918 LIGHT FROM ELECTRONS. Marr, Geoffrey (Reading Univ., Eng.); Munroe, Ian. New Sci. Sci. J.; 49: 266-8(4 Feb 1971).

At the Daresbury Laboratory, Cheshire, building has begun on a new facility costing £360,000 to exploit the extremely intense light source which is a by-product of the electron synchrotron, NINA. By 1972 it should be providing spectroscopists and many other workers with a new experimental tool. The unique properties of this light source are given and the physical origins of the intense blue-white light which comes from within the electron orbit chamber of a synchrotron are outlined. Details of the building to house the facility are given and some of the experiments already planned by various workers are listed. (UK)

33919 OPERATION OF A CONVERGENT-FLOW ELECTRON GUN FOR THIN BEAMS. Mitra, N. K. (Cambridge Univ., Eng.). J. Phys., D (London): 4: 47-53(Jan 1971).

The primary object of this investigation was to undertake a practical survey of the operational features of a scaled-down electron gun with an LM-cathode. In order to accomplish this, a study was made on the effect of reducing the gap between the anode and the cathode-grid assembly on the current density profile across the section of the beam beyond the anode. In particular the value of the peak current density j_m, and the agreement this value has with Langmuir's limit, was studied. The other parameters which are also included in the discussion are the transmission efficiency of the current through the anode and the perveance of the gun. At each of these electrode gaps, the practical values of the above mentioned parameters were observed for different anode-to-cathode voltage in the range 50 to 400 V, in steps of 50 V. For easy reference, these values were plotted on graphs. The profiles of the current density distribution across the section of the beam in the postanode region were found to be very similar to Gaussian, and the parameters of the Gaussian in each case have been computed. The interesting feature of this study was the fact that with this convergent-flow electron gun it is possible to produce beams with peak current densities of the order of 10 A cm^{-2} with a low dc voltage of the order of 400 V between the anode and the cathode. The effect of applying a bias on the grid with respect to the cathode is to cause a general deterioration of the performance. A slight improvement is, however, noticed with a small bias of the order of 0.5 V. (auth) (UK)

33920 RADIAL FOCUSING OF A RING BEAM OF CHARGED PARTICLES UNDER THE ACTION OF COHERENT MAGNETIC BREMSSTRAHLUNG RADIATION. Krasovitskii, V. B. Zh. Eksp. Teor. Fiz.; 60: No. 3, 885-93(Mar 1971). (In Russian).

The possibility of radial stabilization of a ring beam of charged particles by the back effect of magnetic bremsstrahlung radiation is demonstrated. Stability of a finite-thickness relativistic beam is considered and the increments are determined. After this the problem in the nonlinear approximation is solved which yields the size of the focussed beam, the maximal amplitude of the radiation field and the characteristic time of the process. (auth)

33921 CRITICAL CURRENTS IN ELECTRON BEAMS WITH COMPENSATED SPACE CHARGE. Nezlin, M. V.; Taktakishvili, M. I.; Trubnikov, A. S. Zh. Eksp. Teor. Fiz.; 60: No. 3, 1012-20(Mar 1971). (In Russian).

The critical currents in quasi-neutral beams with relatively high electron energies (up to 20 keV) are measured. It is shown that the experimental data can be described by the same laws as those for relatively low electron energies (up to 1 keV). The data are consistent with the viewpoint that the main cause of current restriction in compensated electron beams moving in a longitudinal magnetic field is drift-beam instability. (auth)

33922 CYCLOTRON PRODUCED RADIONUCLIDES: PRODUCTION. Beaver, Joseph (Univ. of Miami, Fla.). pp 136-9 of Central Nervous System Investigation with Radionuclides. /Gilson, Albert J. (ed.). Springfield, Ill.; Charles C Thomas, Publisher (1971).

From second central nervous system investigation with radionuclides seminar; Miami, Fla. (19 Mar 1970). See CONF-700338.

An experimental layout for the Mount Sinai 22-MeV cyclotron for the production of radioisotopes for use in nuclear medicine is briefly described. A partial list of estimated radioisotope yields is presented. (W.H.K.)

33923 SIMPLE AND ACCURATE METHOD OF DETERMINING THE SPATIAL AND ANGULAR PROFILES OF BEAMS FROM

HIGH ENERGY ACCELERATORS. McNulty, P. J. (Clarkson Coll. of Tech., Potsdam, N. Y.). Nucl. Instrum. Methods; 93: No. 1, 179(1971).

The technique and advantages of using nuclear emulsions to obtain beam profiles are discussed. (auth)

33924 NOTE ON PARTICLE TRAJECTORIES IN A HELICAL ELECTROSTATIC QUADRUPOLE. Youssef, E. A.; Chute, F. S.; Vermeulen, F. E. (Univ. of Alberta, Edmonton). Nucl. Instrum. Methods; 93: No. 1, 181-6(1971).

An analytical solution for particle motion in a helical electrostatic quadrupole is discussed in terms of modes at four spatial frequencies. This solution is verified numerically over the entire quadrupole aperture. (auth)

33925 SELF-SUPPORTING TARGET OF SOLID HYDROGEN FOR NUCLEAR PHYSICS EXPERIMENTS. Jarvis, O. N. (Atomic Energy Research Establishment, Harwell, Eng.); Shah, M. Nucl. Instrum. Methods; 93: No. 1, 157-61(1971).

A cryogenic hydrogen target is described in which the hydrogen is in the form of a self-supporting cylinder of solid hydrogen, 1 cm diameter and 5 cm high. With large holes cut through the radiation shields to permit the unhindered passage of charged particle beams, useful target lifetimes of about three hours have been achieved. (auth)

33926 VARIABLE ENERGY BEAMS FROM A FIXED FREQUENCY CYCLOTRON. Golam Mostafa, A. B. M.; Solaija, T. J. (Univ. of Birmingham, Eng.). Nucl. Instrum. Methods; 93: No. 1, 153-6(1971).

Aluminium and graphite absorber foils of various thicknesses have been used to degrade the energy of the proton beams obtained from a fixed frequency cyclotron. Energy resolutions of the degraded beams have been determined from the experimental values. The observed mean energy of the degraded proton beam has been found to agree quite well with calculated values. (auth)

33927 MULTIPURPOSE TARGET CHAMBER. Jensen, B.; Nelson, J. W. (Florida State Univ., Tallahassee). Nucl. Instrum. Methods; 93: No. 1, 137-40(1971).

A target chamber is described which permits efficient counting in neutron-gamma-ray and charged-particle-gamma-ray coincidence experiments. In addition, bearing surfaces are provided for supporting proportional counters around the chamber. Provision is made for positioning any one of six targets, with respect to the beam direction. Easily interchangeable sides permit simple adaptation of the chamber to the requirements of different experiments. (auth)

33928 SAFE HANDLING OF LARGE QUANTITIES OF TRITIUM GAS AT THE LOS ALAMOS TANDEM ACCELERATOR FACILITY. Seitz, T. P.; Woods, R.; Wallis, M.; Henkel, R. L. (Los Alamos Scientific Lab., N. Mex.). Nucl. Instrum. Methods; 93: No. 1, 125-9(1971).

Since June 1965, the Los Alamos Tandem Accelerator Facility has been accelerating triton beams to energies over 20 MeV for unique and interesting experiments in nuclear physics. The use of tritium gas has increased to over 100,000 curies in a year through two electrostatic accelerators having extensive and complicated vacuum systems. The safe handling of these quantities of gas has been accomplished by using closed vacuum systems including cryogenic adsorption of the tritium gas. This system has allowed the recovery of 80% of the tritium gas for reuse and has greatly reduced personnel exposure to tritium. (auth)

33929 IRRADIATIONS IN THE BEAM DUMP OF AN INTERMEDIATE ENERGY PROTON ACCELERATOR. Wynchank, S. (Brooklyn Coll., New York). Nucl. Instrum. Methods; 93: No. 1, 85-91(1971).

The different types of irradiation which are present in a high beam, intermediate energy proton accelerator and means for making them available are described. A discussion is given of the factors involved in choice of elements for use as a beam stop. Estimation of neutron and proton irradiating fluxes, induced radioactivity and shielding are also presented. (auth)

33930 STABILITY CONDITIONS FOR THE SPATIAL FOCUSING IN A RACETRACK MICROTRON. De Mutti, M.; Mancini, E.; Manuzio, G. (INFN, Genoa. Univ., Genoa). Nucl. Instrum. Methods; 93: No. 1, 93-7(1971).

The free parameters available to obtain a beam of limited extension in a racetrack microtron are investigated and discussed. The obtained result may be thought as a generalization of the analogous synchrotron problem. First order transfer matrices are used to approach the problem. The influence of possible approximations is discussed. (auth)

33931 AUTOMATION OF A NUCLEAR PHYSICS LABORATORY BY COMPUTER. I. CONCEPTION AND PROGRAMMING. Bluet, J. C.; Fardeau, P.; Leroy, J. L.; Paternot, Y.; Viers, M. (CEN de Cadarache, Saint-Paul-les-Durance, France). Nucl. Instrum. Methods; 93: No. 1, 35-44(1971). (In French).

An on-line computer is used to operate automatically a 5 MV Van de Graaff accelerator and the associated experimental apparatus. The main parameters to be adjusted are the accelerator energy, the positions of sample and detectors, and the field of an electromagnetic analyser. Usually data acquisition is made on multichannel analysers of scalers used as intermediate memories. At the end of each run this primary data is transfered into the computer for data reduction and editing. Each specific action of the computer on an external device is made by means of a subroutine written in machine language. All these subprogrammes can be called by the main programme, written in FORTRAN. This programme also makes data reduction during data acquisition of the following run. A monitor, always present in the computer memory, may be used to call from a library on magnetic tape and to link one after other several programmes. (auth)

33932 AUTOMATION OF A NUCLEAR PHYSICS LABORATORY BY COMPUTER. II. OPERATION AND INTERFACE. Arnaud, A.; Garnier, Y.; Hebert, D.; Rion, J. (CEN de Cadarache, Saint-Paul-les-Durance, France). Nucl. Instrum. Methods; 93: No. 1, 45-56(1971). (In French).

The hardware used to operate a Van de Graaff accelerator and the associated experiments by means of a computer are described. The computer sets to the proper value before each run the following parameters: accelerator energy and positions of sample and detectors. Furthermore it starts and stops data acquisition. Some regulating devices are then needed to control the Van de Graaff high voltage, the field of the magnetic analyser, and the parameters of the magnetic bunching system. (auth)

33933 SYNCHROTRON RADIATION AS A SOURCE FOR X-RAY DIFFRACTION. Rosenbaum, G. (Max-Planck Institut fuer Medizinische Forschung, Heidelberg); Holmes, K. C.; Witz, J. Nature (London); 230: 434-7(16 Apr 1971).

Some preliminary results are described that were obtained with synchrotron radiation from the 7.5-GeV electron synchrotron, Deutsches Elektronen-Synchrotron (DESY) in Hamburg as a source for x-ray diffraction. (auth) (UK)

33934 INCREASING THE EFFICIENCY OF ALTERNATING-PHASE FOCUSING IN LINEAR ACCELERATORS. Kushin, V. V. This paper was summarized in At. Energ. (USSR); 29: 123-4 (Aug 1970) as paper No. 417/5657. (In Russian).

To achieve alternating-phase focusing, the sign and the absolute magnitude of the synchronous phase are varied periodically along the accelerator in such a way that the average value of the phase over a period is not zero. Equations for the phase and radial motions of the particles are given, and stability conditions are discussed. (W.H.K.)

33935 NANOSECOND RISETIME MEGAVOLT VOLTAGE DIVIDER. Pellinen, D. G.; Heurlin, S. (Physics International Co., San Leandro, Calif.). Rev. Sci. Instrum.; 42: No. 6, 824-7(Jun 1971).

A small linear resistive voltage divider has been used in vacuo for measuring pulsed voltages exceeding 1 MV on electron accelerators. The monitor appears to be linear until breakdown and has a bandwidth greater than 60 Hz to 150 MHz. A method of correcting for nonconservative induced potentials is described as well as several independent calibration methods. (auth)

33936 EXPERIMENTAL SHIELDING STUDIES AT HIGH-ENERGY PROTON ACCELERATORS. A REVIEW. Patterson, H. Wade; Thomas, Ralph H. (Univ. of California, Berkeley). Particle Accel.; 2: No. 2, 77-104(Apr 1971).

Progress during the past ten years in understanding the development of nuclear cascades in matter and its application to high-energy proton-accelerator shielding are described. 97 references. (auth)

33937 DISTORTIONS OF THE PHASE SPACE BEHAVIOR OF A PARTICLE DURING ONE-THIRD INTEGRAL RESONANT EXTRACTION. Month, M.; Courant, E. D. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 2, 105-8(Apr 1971)

Particles can be extracted from a synchrotron continuously over a long period of time, of the order of one second, by using

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the properties of particle motion in the vicinity of a third-integral resonance (that is, the betatron wave number $\nu = k/3$, with k an integer not divisible by three). This slow extraction can be achieved with an azimuthal sextupole distribution having a k^{th} harmonic. Distortions from the ideal resonant extraction conditions due to the nonresonant harmonics of the sextupole distribution (for example, a 0^{th} harmonic coming from the saturation of the lattice magnets) are considered. The use of an azimuthal octupole distribution to correct for these distortions is suggested. (auth)

33938 EFFECT ON ONE-THIRD INTEGER RESONANT EXTRACTION DUE TO SEXTUPOLE FIELDS IN THE LATTICE BENDING MAGNETS. Chasman, R. W.; Month, M. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 2, 109-15(Apr 1971).

Slow extraction in a circular accelerator can be accomplished by providing a sextupole distribution with a kth harmonic, where the integer k is three times the ν value at resonance. It is pointed out that the size of the separatrix (the triangular phase-space region which separates stable from unstable particles) is extremely sensitive to the ν value. On the other hand, the sextupole components in the bending magnets introduce a ν shift which is a function of the amplitude of the particles being extracted. It thus follows that the separatrix will expand as a function of particle amplitude. Under certain circumstances, which are discussed, particles that up to a particular amplitude have remained unstable, will become retrapped by the advancing separatrix created by their own amplitude growth and no extraction can occur. The conditions under which this effect occurs are described and the means by which partial correction can be achieved are discussed. (auth)

33939 IMPOSSIBILITY OF ACHROMATIC FOCUSING WITH MAGNETIC QUADRUPOLES AND SOLENOIDS. Courant, E. D. (Brookhaven National Lab., Upton, N. Y. State Univ. of New York, Stony Brook). Particle Accel.; 2: No. 2, 117-19(Apr 1971).

The theorem that a quadrupole focusing system cannot produce a line focus whose location is independent of momentum is generalized to cover any magnetic field distribution in which the central trajectory is a straight line. (auth)

33940 SINGLE PARTICLE THEORY OF PLASMA BETATRONS. Ferrari, L. A. (Queens Coll., New York); Zucker, M. S. Particle Accel.; 2: No. 2, 121-31(Apr 1971).

Particle orbits in combined betatron and azimuthal magnetic fields are computed using the guiding center approximation as well as the single particle equations directly. Particular attention is given to the start of the acceleration cycle. The problem of capture into betatron orbits in a plasma betatron without azimuthal field is considered. It is found that a finite electron temperature places severe restrictions on the beam current. It is shown that a plasma must be formed with a static azimuthal magnetic field already established and that beam loss via scattering is negligible. Finally some new types of plasma betatron experiments are suggested. (auth)

33941 DUOPLASMATRON PARAMETERS FOR OPTIMUM POSITIVE OR NEGATIVE ION YIELD. Abroyan, M. A.; Golubev, V. P.; Komarov, V. L.; (and others) (Scientific Research Inst. of Electrophysical Apparatus, Leningrad). Particle Accel.; 2: No. 2, 133-9(Apr 1971).

Three modifications of a duoplasmatron type ion source are described. Results of investigation of these sources are given. The pulsed duoplasmatron makes it possible to obtain a hydrogen ion beam with current up to 2A. The phase-space density is 600 mA/mrad · cm for 800 mA output current. Proton percentage in the beam is 90%; the heavy ion component does not exceed 2%. The duoplasmatron for obtaining positive ions of hydrogen provides a beam with current from 2 to 60 mA. In this case one can obtain up to 70% H_1^+, up to 60% H_2^+, or up to 70% H_3^+. A system of diagrams is provided for selection of parameters of the source power supply and the source geometry. The duoplasmatron for obtaining negative ions gives an H_1^- ion beam with current up to 150 μA. Gas leakage is about 0.7 cm^3/hour at atmospheric pressure per 1 μA current of H_1^-. Normalized emittance is 0.005 mrad · cm. (auth)

33942 SIMPLE DERIVATION OF PROTON LINAC BEAM DYNAMICS EQUATIONS. Schnizer, B. (CERN, Geneva. Technische Hochschule, Graz). Particle Accel.; 2: No. 2, 141-7(Apr 1971).

The non-relativistic difference equations describing the motion of a single proton through an Alvarez structure linac gap given by P. Lapostolle at the Frascati Conference (1965) are derived in a very simple way. Beam dynamics coefficients (T and S transit time coefficients) are defined as Fourier transforms of the rf field in the gap. The equations of motion and the difference equations are transformed by the introduction of thin lens (reduced) variables. The equations of motion are solved by iteration starting from free particle motion. First order results can be found by identifying the integrals of the transformed equations of motion with those of the beam dynamics coefficients. (auth)

33943 HELICAL WAVEGUIDES FOR HEAVY PARTICLE LINACS. Sierk, A. J.; Hamer, C. J.; Tombrello, T. A. (California Inst. of Tech., Pasadena). Particle Accel.; 2: No. 2, 149-67(Apr 1971).

The properties of helical waveguides for use as heavy particle accelerators are investigated, and a new method of focusing is proposed that involves neither quadrupoles nor shaped electrodes. These calculations include estimates of mechanical stability, electrical losses, and the effects of finite helix wire size. In addition, the double helix waveguide is analyzed; this structure may be practical for ions with initial velocities below 0.01 C. (auth)

33944 COMPUTATION OF HIGH-FIELD MAGNETS. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, N. Y.). Particle Accel.; 2: No. 2, 169-79(Apr 1971).

A computer program (GRACY) used in the study of high-field superconducting magnets is described. Some of the techniques developed in this program, and the application of the program to some particular magnets are presented. The topics discussed include the formulation of the problem, the iteration procedure, the current-density calculation, convergence problems, accuracy problems, derivation of the iteration coefficients, and procedures for terminating the mesh. (auth)

33945 EFFECT OF SIMULTANEOUS PHASE ERROR AND PHASE JITTER ON THE ENERGY RESOLUTION OF MULTISECTION ELECTRON LINACS. Herminghaus, H. (Univ., Mainz). Particle Accel.; 2: No. 2, 181-4(Apr 1971).

The output energy fluctuations of multisection electron linacs due to klystron voltage fluctuations are calculated assuming phase misalignments. It is shown that under realistic conditions the influence of klystron phase jitter may give a larger contribution than amplitude jitter. (auth)

33946 FORMATION OF AN ELECTRON RING IN A STATIC MAGNETIC FIELD. Nelson, David Lawrence. College Park, Md.; Univ. of Maryland (1970). 139p. University Microfilms Order No. 71-10,484.

Thesis.

The formation of a relativistic electron ring using a static magnetic field is proposed as a means of creating a vehicle which can be used to accelerate positive ions to very high energy. A betatron field and a cusped field, both using a cylindrical hollow beam, are studied and the results of theoretical calculations and numeric integration of equations of motion are described comparing their relative characteristics. A method for radially centering a rotating cylindrical beam, and its use during formation to control the electron ring's radial motion is proposed. The self force of an electron ring and the effects of induced charge in inner and outer conducting walls are calculated, and a variety of numerical techniques is described. (Diss. Abstr. Int., B)

33947 USE OF COPPER UNDER EXTREME OPERATING CONDITIONS AT CERN. Pawlek, F. (CERN, Geneva). Metall; 24: 1176-9(Nov 1970). (In German).

The 28-GeV proton synchrotron at CERN has been in operation for 10 years. There are 8.7 tons of copper winding in the magnets of the synchrotron. The preparation of the windings and the high quality requirements placed on them are described. (J.S.R.)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 32488, 32493, 33367, 33374, 33381, 33383, 33399, 34113, 34402, and 34423.

33948 (ANL–7780) DBLSCAT: A COMPUTER CODE FOR DOUBLE-SCATTERING CORRECTIONS. Agrawal, A. K.; Das, S. G.; Mueller, F. M. (Argonne National Lab., Ill.). Feb 1971. Contract W-31-109-eng-38. 30p. Dep. NTIS.

DBLSCAT, a FORTRAN IV computer program for calculating the second-order scattering correction for double-differential slow-neutron scattering experiments in an infinite, plane-slab geometry is described. Included are a brief description of the theory (with special cases), a discussion of numerical techniques used, input and output descriptions, sample problems, and the FORTRAN IV listing of the computer code. The program allows for both transmission- and reflection-type experiment geometries. The method used to calculate double-scattering correction is based on Vineyard's approach [Phys. Rev., 96: 93(1954)], except that there are no assumptions regarding the nature of the scattering cross section. Triple integrations appearing in the expression for second-order scattered-neutron current are carried out using a specified number of mesh points. Corrections due to finiteness of sample and higher-order scattering effects are not included. The code was written with particular emphasis on efficiency and compactness. For a typical run, it takes approximately one minute of the IBM 360/75 processor time in the quasi-elastic region and about 10 sec in the inelastic region. The code uses about 85K bytes. (auth)

33949 (Y-DR–41) USE OF ^{252}Cf AS A RANDOMLY PULSED NEUTRON SOURCE FOR PROMPT NEUTRON DECAY MEASUREMENTS. Mihalczo, J. T. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 6 Jan 1971. Contract W-7405-eng-26. 104p. Dep. NTIS.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Cross correlation measurements were performed for unmoderated and polyethylene-moderated uranium (~93 wt % ^{235}U) assemblies with prompt neutron decay constants varying from 3×10^3 to 10^6 sec^{-1}. One of the detectors was an ionization chamber containing ^{252}Cf which triggered the time analysis equipment every time a spontaneous fission of Cf occurred. The other was a proton recoil scintillator which measured the response of the multiplying assembly to the neutrons emitted in the Cf fission. These measurements used Cf as a randomly pulsed neutron source but had the simplicity of the Rossi-α technique. The randomly pulsed neutron method allowed the measurement of the prompt neutron decay without the use of a complicated pulsed neutron source where Rossi-α measurements were not practical. In assemblies for which Rossi-α measurements were also made, the prompt neutron decay constant agreed within the precision of the measurements with those obtained by this technique. The ratio of the correlated count rate in a randomly pulsed neutron measurement to that in a Rossi-α measurement was inversely proportional to the detector efficiency. This ratio was quite large for some assemblies; i.e., it was 7,900 for a cylindrical assembly of 38.09-cm-diam, 0.303-cm-thick uranium discs with 38.07-cm-diam, 0.628-cm-thick polyethylene discs between the uranium discs. The uranium mass in this assembly was ~½ the critical mass. This type of source provided a good simple way to determine the characteristics of detection systems since the time at which the neutrons or gamma rays from fission enter the detector was known. It was used to determine detector efficiency, time resolution, and to evaluate in a quantitative way the performance of a gamma discrimination method. (auth)

33950 INVESTIGATION OF NEUTRON SLOWING–DOWN DYNAMICS. Rooney, Vernon Lonnie Jr. Tucson, Ariz.; Univ. of Arizona (1970). 107p. University Microfilms Order No. 71-8434.

Thesis.

The time required for fast neutrons to slow to epithermal energy, including the variation of slowing-down density with time, was measured in graphite. Measurements were performed at ten different spatial locations ranging from 24 to 51 centimeters from the source and with three different terminal energy spectra achieved by shielding the BF_3 detector with cadmium, cadmium and indium, and cadmium and gold foils. A 2.0-MeV Van de Graaff accelerator was used to produce fast neutrons by means of a ^{7}Li (d,n)^{8}Be reaction in a target centered within a graphite block 120 centimeters by 120 centimeters by 126 centimeters in size. Sinusoidal modulation of the accelerator beam from 80 to 100,000 Hz by an electrostatic lens produced a sinusoidally varying fast-neutron source that could be compared with the measured epithermal wave by Fourier analysis. An analytical method, termed time–frequency mapping, for relating measured amplitude and phase shifts to corresponding slowing-down densities and times was developed. Results were compared with slowing-down times predicted by theoretical models developed by Fermi, Dyad'kin, and Claesson. Mean slowing-down times were found to agree most closely with the Fermi model, and variation of the slowing-down density with time was found to closely approximate the Claesson and Dyad'kin models. Results of this analysis by frequency-time mapping were compared with analysis of the same experimental results by frequency spectrometry and Monte Carlo calculations by another investigator and found to agree well. (Diss. Abstr. Int., B)

33951 TWO–GROUP TRANSPORT SOLUTIONS TO THE ONE-DIMENSIONAL CRITICAL SLAB PROBLEM. Forster III, Robert Arthur. Charlottsville, Va.; Univ. of Virginia (1970). 295p. University Microfilms Order No. 70-26,553.

Thesis.

The singular-eigenfunction approach is applied to the steady-state, two-energy-group neutron transport equations to solve the one-dimensional, bare, uniform, critical-slab problem. Exact expressions for the criticality condition and neutron distributions are obtained that are similar to, but more complicated than, the one-group results. These expressions are dependent on the expansion coefficients, which are determined numerically from a set of coupled singular integral equations for both one and two pairs of discrete roots. For large systems, the exact expressions reduce to two-group diffusion theory. Numerical results from the singular-eigenfunction approach are presented for various systems and compared with the diffusion-theory, P_1, P_3, DP_1, and S_N (N = 4, 8, and 16) approximations. The best approximations for criticality, in order of increasing accuracy, are the P_1, diffusion-theory, S_4, P_3, S_8, DP_1, and S_{16} approximations. The order of increasing accuracy for the total flux predictions is diffusion-theory, P_1, P_3, S_4, DP_1, S_8, S_{16}. This study shows that the DP_1 method, which is a moderately simple approximation, yields quite accurate results even for thin systems. The results of this study serve as a guide as to what approximation should be used to yield accurate results with a minimum of computational effort. Comparison with other techniques is also possible because the critical half-thicknesses are accurate to four or five digits, as reported. (Diss. Abstr. Int., B)

33952 CONTINUUM MODES IN NEUTRON WAVE PROPAGATION IN GRAPHITE. Ghatak, A. K.; Singh, Om Pal; Bansal, N. K. (Indian Inst. of Tech., New Delhi). J. Nucl. Sci. Technol. (Tokyo): 8: 230-3(Apr 1971).

Equations are derived for the wave propagation of neutrons from an isotropic sinusoidally modulated source in graphite. Numerical calculations were made for the complete structure of the eigenvalues for frequencies of 50 and 300 Hz. Except for the fundamental mode, all the other modes lie almost on the cut in the ρ^2 plane. (D.L.C.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 33765, 33982, 34077, 34141, and 34143.

33953 (INR–1252) POLARIZATION OF NEUTRONS FROM THE ^{3}H(d,n)^{4}He REACTION AT LOW DEUTERON ENERGIES. Sieminski, M.; Wilhelmi, Z.; Zych, W.; Zupranski, P.; Rondio, J. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 3p. Dep. NTIS (U. S. Sales Only).

The results of measurements of neutron polarization from the ^{3}H(d,n)^{4}He reaction are presented. Variation of neutron polarization vs deuteron energy has been studied at neutron emission angles 60° and 90° in the laboratory system for deuteron energies from 0.5 to 1.6 MeV. Angular distribution of neutron polarization has been measured at a deuteron energy of 1.4 MeV. (auth)

33954 (USC–136-X-1) ANNUAL PROGRESS REPORT OF THE U.S.C. NUCLEAR PHYSICS RESEARCH LABORATORY. (University of Southern California, Los Angeles. Nuclear Physics Lab.). Oct 1970. Contract AT(04-3)-136. 52p. Dep. NTIS.

FLUORINE-19—proton reactions (p,He-3) and (p,t) with, DWBA analyses of, (E)

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—proton reactions (p,pd) and (p,pt) with, summed energy spectra from, (E)
HELIUM-3—proton reactions (p,2p) and (p,pd) at 40 MeV, energy spectra from, (E)
SCANDIUM-45—proton reactions (p,α), (p,He-3), (p,Li-6), and (p,Li-7) at 45 MeV, differential cross sections for, (E)
TRITIUM—proton reactions (p,2p) and (p,pd) at 35 MeV, energy spectra from, (E) (J.W.R.)

33955 OFF-ENERGY-SHELL EFFECTS IN THE TRITON WITH THE BOUNDARY-CONDITION INTERACTION. Hoenig, Milton M. (Southeastern Massachusetts Univ., North Dartmouth). Phys. Rev., C; 3: 1118-27(Mar 1971).

The boundary-condition model of the two-nucleon interaction due to Feshbach and Lomon is used without an external potential tail to determine the ground-state properties of the three-nucleon system for the purpose of studying the off-energy-shell properties of the two-body T matrix. Calculations are performed using an average singlet-triplet s-wave interaction giving a completely symmetric triton wave function. The T matrix is separable and depends on three energy-independent parameters—the boundary radius r_0 and the boundary condition f at $r_0 + \epsilon$ which are determined from the two-nucleon phase shifts, and the boundary condition b at $r_0 - \epsilon$ which is specifically an off-shell parameter that does not appear in the on-shell T matrix. With f = 0.11 and r_0 = 0.95 F, the Faddeev equations are solved for the triton energy eigenvalues and spectator functions for several values of b. It is found that the binding energy varies from 3.9 to 19.4 MeV for b between 0.5 and 0.6, with a value of 8.5 MeV at r = 0.537. The average kinetic energy and charge form factor are determined as a function of b, the qualitative agreement of the charge radius with experiment is obtained for b = 0.5 – 0.6. The charge form factor, compared with experiment, does not drop off rapidly enough with q^2, indicating the presence of relatively too much large q component in the spectator functions. The changes to be expected from the inclusion of tensor coupling in the boundary parameters are discussed. (auth)

33956 MULTIPLE SCATTERING OF PIONS BY DEUTERONS. Gibbs, W. R. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 3: 1127-36(Mar 1971).

The general theory of multiple scattering of pions from nuclei is expressed in a way which does not require the use of a series expansion. In an on-shell approximation this theory may be reduced to the solution of a set of A coupled integral equations. As a demonstration of the method the equations are specialized to the case of the deuteron and solved to give comparison with the experimental data. The deuteron tensor T_{20} is shown to be sensitive to the percentage of D state for deuterons scattered at 0°. (auth)

33957 NUCLEON–NUCLEON CORRELATION IN NUCLEI AND ELASTIC ELECTRON SCATTERING ON ^{4}He NUCLEUS. Dzhibuti, R. I.; Mamasakhlisov, V. I. (Inst. of Physics, Tbilisi, USSR). Yadern. Fiz.; 13: 73-9(Jan 1971). (In Russian).

An analytic expression for the correlation function providing the fullest account of the Pauli principle is constructed on basis of a new two-nucleon nonlocal potential: $\langle r|v|r'\rangle = \frac{1}{2}\{V(r)\delta(r') + V(r')\delta(r)\}$. The ^{4}He nuclear binding energy calculated on the basis of this function by means of the Bruckner–Hartree–Fock method is in reasonable agreement with the experimental value. It is shown that the present correlation function describes satisfactorily the position of the minimum in the form factor as well as the general behavior with variation of the electron momentum transfer in the interval $0 \leq q^2 \leq 20\ f^{-2}$. (auth)

33958 NEUTRON POLARIZATION IN THE d + T → n + ^{4}He REACTION AT 30° FROM 3 TO 15 MeV. Mutchler, G. S.; Broste, W. B.; Simmons, J. E. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 3: 1031-42(Mar 1971).

An experimental study was made of neutron polarization from the T(d,n)^{4}He reaction at 30° lab as a function of incident deuteron energy. A liquid-helium polarimeter was employed for this purpose with a 90° spin-precession solenoid. Measurements were made in two ways, with greatest emphasis placed on the use of the backward reaction, D(t,n)^{4}He, for a range of triton energies between 4.5 and 19.5 MeV. Equivalent c.m. conditions are obtained for $E_t = \frac{3}{2}E_d$, with neutrons emerging in the vicinity of 135° lab. Under these conditions, the neutron energy is near 11 MeV over a wide range of triton energies, where the n-He analyzing power is constant and well known. Measurements were also made from the T(d,n)^{4}He reaction directly at 30° for a range of deuteron energies between 5 and 15 MeV. The measured polarizations varied from 0.03 at 3-MeV to 0.69 at 13-MeV equivalent deuteron energy. Comparisons are made with prior data. The method also allows extraction of values of the n-He analyzing power for neutron energies between 21 and 29 MeV at 75 and 113° lab. (auth)

33959 NEW ASPECTS OF (n,p) SCATTERING IN ZIRCONIUM HYDRIDE. Keinert, J. (Univ., Stuttgart). Atomkernenergie; 17: 209-14(May 1971). (In German).

A comparison of calculations with different frequency distributions is made with measured neutron cross sections and spectra for zirconium hydride. The influence of the parameters of these distributions on differential and integral data is examined. A simple analytic frequency distribution, which is able to give excellent agreement with measured spectra, is derived. It is shown that the more physical model of Slaggie (central-force lattice-dynamical model) is not able to calculate neutron spectra quantitatively. The results of a Nelkin frequency distribution are not very good; this model is not useful for exact calculations. The basis of the calculations is the well-known theory of neutron scattering in metal hydrides (harmonic vibrations of the hydrogen atom in the zirconium tetrahedron, isotropic crystal, Born approximation because of Fermi pseudopotential, incoherent approximation of H-scattering). (auth)

33960 CALCULATION OF THE ^{3}He CHARGE FORM FACTOR. McMillan, Malcolm (Univ. of British Columbia, Vancouver). Phys. Rev., C; 3: 1702-4(Apr 1971).

The ^{3}He charge form factor is calculated using phenomenological mixed symmetric S- and D-state wave-function components along with the symmetric S-state component developed previously from the Bressel–Kerman–Rouben potential by using an altered Feshbach–Rubinow equivalent two-body method. A zero of the form factor near the experimental value is found for reasonable S′ and D admixtures. This appears to weaken a suggestion by Tjon, Gibson, and O'Connell concerning the nucleon–nucleon interaction. (auth)

33961 ELECTROMAGNETIC FORM FACTORS AND RADII OF ^{3}He. Lim, T. K. (Florida State Univ., Tallahassee). Phys. Rev., C; 3: 408-10(Jan 1971).

The electromagnetic form factors and radii of ^{3}He have been evaluated using the three-body wave function obtained from a perturbational solution of the trinucleon system with the Eikemeier–Hackenbroich potential. The effect of S′-state admixture and magnetic-exchange interactions are included in the calculation. Satisfactory fits to the form factors to large momentum transfer, including the correct prediction of the location of the diffraction minimum in the charge form factor, are found. The calculations are in agreement with the latest Stanford e-^{3}He results in suggesting that the magnetic radius is larger than the charge radius if suitable magnetic-exchange effects are considered. (auth)

33962 ASYMMETRY OF PROTON ANGULAR DISTRIBUTIONS FROM REACTION ^{4}He(γ,p)^{3}H. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 256-8(Feb 1971). (In Russian).

Angular distributions of protons from reaction ^{4}He(γ,p)^{3}H are studied in more narrow energy regions than was done previously. The coefficient rapidly increases with energy from the reaction threshold up to 25 MeV. It is constant at 25 to 30 MeV and increases again within 30 to 32 MeV. Above 32 MeV the asymmetry coefficient remains constant in a wide energy region. (auth)

33963 QUASI-ELASTIC ELECTRON SCATTERING AND INELASTIC ELECTROMAGNETIC FORM FACTORS OF ^{11}B, ^{27}Al, AND ^{28}Si. Vlasenko, V. G.; Afanas'ev, N. G.; Gol'dhstein, V. A.; Dementii, S. V.; Kuplennikov, E. L. (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 259-67(Feb 1971). (In Russian).

The results are given of experimental study of inelastic 600 to 1150 MeV electron scattering by ^{11}B, ^{27}Al, and ^{28}Si within the 17 to 60° angle region. The cross section obtained in the electron scattering by ^{11}B, ^{12}C, and ^{27}Al, ^{28}Si, is compared. The values of inelastic electromagnetic form factors of nuclei with the momentum transfer squares $2F^{-2} < q_\mu^2 \lesssim 10F^{-2}$ are obtained, taking into account the cross sections measured in the continuum maximum. It is shown that the experimental data in the continuum region are in agreement with the theory of quasi-elastic electron scattering by the nucleons of nuclei. Values of the m.s. radii for the nuclei ^{11}B, ^{12}C, ^{27}Al, ^{28}Si, ^{32}S obtained analyzing the quasi-elastic scattering are found to be systematically underestimated as compared with those determined from the elastic electron scattering. (auth)

33964 SYMBOLIC CALCULATION CODE FOR NUCLEAR THREE-BODY PROBLEM. Chmura, Takashi; Fujii, Hiroshi; Maeda, Eijiro (Nihon Univ., Tokyo, Kyoto Sangyo Univ. UNIVAC Research Inst., Tokyo). J. Comput. Phys.; 7: 61-82(Feb 1971).

A computational method is described for the Rayleigh–Ritz

variational method for solving the nuclear three-body problem where the hard core is included in the two-body potentials. Formula-manipulation techniques are developed to carry out all the required differentiation and complicated integrations analytically, and these were proved to be useful on a high-speed computer. (auth)

33965 ^{3}He(d,p)^{4}He REACTION AT 0^0 AS AN ANALYSER FOR TENSOR POLARIZED DEUTERONS. Grueebler, W.; Koenig, V.; Ruh, A.; (and others) (Eidgenoessische Technische Hochschule, Zurich). Nucl. Phys.; A165: 505-7(1971).

The tensor analyzing power T_{20} of the ^{3}He(d,p)^{4}He reaction was measured at $\theta = 0^\circ$ between 2 and 11.2 MeV. This reaction shows excellent properties as an analyzer for tensor polarized deuteron beams. (auth)

33966 ENERGY DEPENDENCE OF POLARIZATION OF THE EMITTED PROTONS FROM THE REACTION ^{3}He(d,p)^{4}He. Khangulyan, V. A. (Moscow Engineering Physics Inst.). Yadern. Fiz.; 13: 525-33(Mar 1971). (In Russian).

Polarization of the emitted protons from the reaction ^{3}He(d,p)^{4}He is analyzed assuming that the reaction mechanism is dominated by the pole graph and the graphs describing the initial- and final-state interactions. It is shown that the polarization in this model is determined only by the triangle graph that corresponds to the initial-state interaction. Conditions for the invariant amplitudes of the elastic ^{3}He + d scattering are obtained under which there is an agreement with the experimental energy dependence of the polarization of emitted protons from the reaction ^{3}He(d,p)^{4}He. (auth)

33967 COMPARISON BETWEEN HARTREE–FOCK AND FIRST ORDER HYPERSPHERICAL CALCULATIONS FOR THE α PARTICLE. Fabre De La Ripelle, M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 495-8 (Mar 1971). (In Russian).

Comparison is given between Hartree–Fock and first order hyperspherical calculations for the α particle. The investigated potentials are superposition of Gaussians with repulsive cores. A method for obtaining an estimate of the binding energy of ^{4}He is proposed. This first order hyperspherical approximation gives always a binding energy lower than the Hartree–Fock method. (auth)

33968 THEORY OF (π^-,2N) REACTIONS WITH STOPPING π^- MESONS ON LIGHT NUCLEI. Kopaleishvili, T. I.; Machabeli, I. Z.; Chachkhunashvili, M. Sh. (Tbilisi State Univ., USSR). Yadern. Fiz.; 13: 534-40(Mar 1971). (In Russian).

Effects of the rescattering in the pion interaction with pairs of nucleons and of the final-state interaction between the emitted nucleons in the (π^-,2N) reaction are discussed for the deuteron and ^{16}O as examples. It is shown that: (I) the deuteron D state has an essential influence on the relation between the two effects; (II) the rescattering affects not only the reaction probability for the ^{16}O nucleus but also the relative yield of the (n,n) and (n,p) reactions, as well as angular correlation function for the emitted nucleons; (III) the available experimental data may be explained assuming that the π^--mesons are absorbed by a symmetrical (N,N) pair in the nucleus. A discussion is presented which shows that such a mechanism cannot be reduced to the quasideuteron absorption. (auth)

33969 HIGH-ENERGY ELECTRON SCATTERING AND NUCLEAR STRUCTURE. Khanna, F. C. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Nucl. Phys.; A165: 475-96 (1971).

The charge form factor of ^{3}H, ^{3}He, ^{4}He, ^{16}O, ^{40}Ca and ^{48}Ca is calculated using correlated basis functions. A cluster expansion for the charge form factor is written down and terms up to two-particle clusters are retained. It is found that a consistent explanation for the diffraction structure at large momentum transfer can be obtained in terms of the short-range correlations in the nuclear wave function. The experimental results for the charge form factor are quite well reproduced. (auth)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 32265, 33621, 33645, 33646, 33954, 33963, 33968, 33969, 34021, 34077, 34082, 34141, and 34143.

33970 (ANU-P-520) MAGNETIC ANALYSIS OF THE REACTIONS ^{7}Li(^{3}He,d)^{8}Be AND ^{7}Li(^{3}He,t)^{7}Be. Piluso, C. J.; Spear, R. H.; Carter, K. W.; Kean, D. C.; Barker, F. C. (Australian National Univ., Canberra. Research School of Physical Science). [1969]. 24p. Dep. NTIS (U. S. Sales Only).

The reactions ^{7}Li(^{3}He,d)^{8}Be and ^{7}Li(^{3}He,t)^{7}Be were studied at a bombarding energy of 15 MeV. Energy spectra of deuterons and tritons were measured at laboratory angles of 10° and 25° using a broad-range magnetic spectrograph. In the range of excitation energies from 0 to 18 MeV in ^{8}Be, no evidence was found for the existence of previously unreported narrow states that are suggested by systematics and simple models. The measured position and width of the 2.9-MeV 2^+ level of ^{8}Be are in good agreement with values obtained previously from the reaction ^{9}Be(p,d)^{8}Be, this agreement suggesting that the broad 2^+ states at higher excitation energies have little 1p–1h character. The deuteron spectra in the neighborhood of the 16.6- and 16.9-MeV levels of ^{8}Be show interference effects which agree well with shell-model predictions. The width of the 4.55-MeV $^7/_2^-$ level of ^{7}Be was found to be (175 ± 7) keV, which differs considerably from the previously reported value. (auth) (Australia)

33971 (JINR-P2-5261) CERTAIN CHARACTERISTICS OF FAST DEUTERON INTERACTIONS WITH NUCLEI. Gudima, K. K.; Kirillov, A. D.; Toneev, V. D.; Yakovlev, Yu. P. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 11p. (In Russian). Dep. NTIS (U. S. Sales Only).

The interaction of fast deuterons with nuclei in a photoemulsion was investigated. The 600-MeV deuterons were obtained in an electrostatic separation channel at an intensity of 20 deuterons per 1×10^{10} incident protons. The 250-μ thick photoemulsion was irradiated by this beam up to a rate of 0.5×10^5 particles/cm^3 at the highest track density region. The experimental correlations were based on the statistical study of 500 stars. The results revealed inelastic deuteron–nucleon collision data involving 2 independent nucleon cascades does not yield sufficient information concerning the behavior of individual components. It is possible that the reaction mechanism involved is more complex than has been assumed, as indicated in the case of some of the large stars. The lowered theoretical yield in the 60 to 120° angular range may be attributed to the fact that the quasi-free scattering of deuterons on the nucleons was not taken into account. (TTT)

33972 (KFK-1357) DIFFERENTIAL CROSS SECTION AND VECTOR POLARIZATION FOR THE ELASTIC SCATTERING OF 41 TO 51 MeV DEUTERONS ON CARBON. Fetscher, W.; Sattler, K.; Schmeing, N. C.; Seibt, E.; Staudt, R.; Weddigen, Ch.; Weigele, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Jan 1971. 16p. (CONF-700811-15). Dep. NTIS (U. S. Sales Only).

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (31 Aug 1970).

Differential cross section and vector polarization for the elastic scattering of 41, 46, and 51 MeV deuterons on ^{12}C were obtained from single and double scattering experiments at the Karlsruhe isochronous cyclotron. Tensor polarization effects were found to be small. The experimental data are compared with the results of optical model calculations. Best fits to the polarization data are obtained with volume spin-orbit terms for the deuteron optical potential. (auth)

33973 DISTORTED-WAVE ANALYSIS OF THE ^{13}C(^{3}He,d) REACTION LEADING TO UNBOUND LEVELS OF ^{14}N. Fortune, H. T. (Univ. of Pennsylvania, Philadelphia); Middleton, R.; Garrett, J. D.; Holbrow, C. H. Phys. Rev., C; 3: 1441-4(Apr 1971).

Distorted-wave calculations are compared with data from the ^{13}C(^{3}He,d)^{14}N reaction leading to proton-unbound levels at E_x = 7.966 MeV (2^+, T = 0), 8.489 MeV (4^-, T = 0), 8.617 MeV (0^+, T = 1), and 8.907 MeV (3^-, T = 1). Results show appreciable nondirect components for population of the 4^- and 0^+ states. The 7.966-MeV state is suggested to have positive parity, and a definite prediction is made for its width. The spectroscopic factor for the 3^-, T = 1 state approaches unity, in good agreement with theoretical calculations. (auth)

33974 EFFECTIVE INTERACTION AND LEVEL STRUCTURE OF NUCLEI WITH FREE NUCLEON-NUCLEON INTERACTION. Jain, M. C.; Mehta, G. K.; Waghmare, Y. R. (Indian Inst. of Tech., Kanpur). Phys. Rev., C; 3: 1466-75(Apr 1971).

Effective interactions and energy levels of light and intermediate nuclei (^{6}He, ^{6}Li, ^{18}O, ^{18}F, and ^{58}Ni) are calculated using the interaction of Shakin and his collaborators derived from the Yale potential through the unitary-model-operator approach. Detailed comparison is made with works of Kuo–Brown and other authors. It is found that the differences in the approximations used by different groups of workers in the evaluation of the reaction matrix elements can lead to large differences in the spectra: this indicates that it is very necessary to evaluate

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the reaction matrix elements more precisely before applying them to nuclear-structure calculations. (auth)

33975 NEUTRON TRANSFER TO THE GROUND STATE OF ^{14}C IN THE $^{13}C(^{14}N,^{13}N)^{14}C$ REACTION. Gaedke, R. M. (Oak Ridge National Lab., Tenn. Trinity Univ., San Antonio, Tex.); Tobocman, W.; Toth, K. S. Phys. Rev., C; 3: 1444-8(Apr 1971).

Thick targets of ^{13}C (91.7%) were bombarded with ^{14}N ions accelerated in the Oak Ridge tandem Van de Graaff, and the cross section for the neutron-transfer reaction $^{13}C(^{14}N,^{13}N)^{14}C$ was measured from 12.5 to 20.5 MeV. The cross section measured in this energy range is due predominantly to transfers that proceed to the ^{14}C ground state, since the threshold for the reaction to populate the 6.09-MeV first excited state is 17.6 MeV. The measured excitation function is compared with cross sections calculated from the recent distorted-wave Born-approximation (DWBA) treatment of Schmittroth, Tobocman, and Golestaneh. It is possible to find an optical potential for which the DWBA matched the observed excitation function above 14 MeV (lab) incident energy. From this fit the spectroscopic factor for the ^{14}C ground state is determined. The excitation function for the compound-nucleus reaction $^{13}C(^{14}N,2p)^{25}Na$ was also measured for ^{14}N incident energies from 13.5 to 20.5 MeV. (auth)

33976 DECAY OF ^{11}Be. Alburger, D. E. (Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H. Phys. Rev., C; 3: 1492-1503(Apr 1971).

The β decay of ^{11}Be, formed in the $^{9}Be(t,p)^{11}Be$ reaction, was investigated using Ge(Li) and NaI(Tl) γ-ray detectors and Si α-particle detectors. Eight γ-ray transitions were measured including three weak γ rays with energies of 1772, 2893, and 5019 keV not observed previously in ^{11}Be decay. The relative γ intensities show that the 5020-keV state of ^{11}Be is populated by a ^{11}Be first-forbidden β-ray branch of 0.28% (log ft = 7.94 ± 0.14), as well as by a cascade γ-ray branch of 4.1% from the ^{11}B 6793-keV state. Other previously observed β-ray branches were confirmed. Accurate energies were obtained for the ^{11}B states, including a value of 7978.1 ± 1.9 keV for the seventh excited state. This is 18 keV lower than in previous reports. Delayed α particles were also found in ^{11}Be decay; the experimentally observed α-particle spectrum is a continuum extending from an instrumental lower limit of 0.3 MeV up to about 1.0 MeV, with a total α-particle intensity of 3.0% per decay. These α particles are not in coincidence with 478-keV γ rays from ^{7}Li. It is suggested that this β-ray branch of ^{11}Be proceeds to the 9870-keV, $J^{\pi} = 3/2^{+}$ state of ^{11}B (log ft = 4.03 ± 0.15), which decays by α-particle emission to the ground state of ^{7}Li, although an α-decay branch to the 478-keV state of ^{7}Li cannot be excluded. The new features of ^{11}Be decay are discussed. It appears that the analog in ^{11}B of the ground state of ^{11}Be has no antianalog. (auth)

33977 INELASTIC SCATTERING OF PROTONS FROM ^{16}O AND THE SPIN-DEPENDENT PART OF THE EFFECTIVE INTERACTION. Austin, Sam M. (Michigan State Univ., East Lansing); Locard, P. J.; Bunker, S. N.; (and others). Phys. Rev., C; 3: 1514-27(Apr 1971).

Angular distributions for the $^{16}O(p,p')^{16}O$ reaction leading to the $J^{\pi} = 2^{-}$ state at 8.88 MeV and the doublet of states at 6.05 MeV (0^{+}) and 6.13 MeV (3^{-}) were measured at 23.4, 24.5, 27.3, 30.1, 34.1, 36.8, 39.7, 43.1, and 46.1 MeV. In the distorted-wave approximation (DWA) with central forces, the transition to the unnatural-parity (2^{-}) state can occur only through the spin-dependent part $V_{10} = V_{\sigma}f(r)\vec{\sigma}_i \cdot \vec{\sigma}_p$ of the effective two-nucleon interaction. The experimental angular distributions were compared with DWA calculations with the assumption that f(r) has a Yukawa shape with a range of 1.0 F. Normalization to the measured cross sections determined the strength V_{σ}, which was found to decrease rapidly from a magnitude of 53 MeV to about 23 MeV between E_p = 17.0 MeV and E_p = 30.1 MeV and then to decrease slowly to about 16 MeV at E_p = 46.1 MeV. The shape of the experimental angular distributions for the inelastic scattering to the 2^{-} state is well represented by the DWA at the lower energies, but the agreement deteriorates as the energy increases. The forward peak in the higher-energy data occurs at larger angles than the DWA prediction. The cross section calculated using a pseudopotential derived from the impulse approximation is too small by a factor of about 4 at all energies. The possible contribution of other reaction mechanisms to the cross section for scattering to the 2^{-} state is discussed. An analysis of the transition to the 6.1-MeV doublet is used to estimate the strength V_c of the spin–isospin-independent part V_{00} of the effective two-nucleon interaction. The experimental angular distributions for the 6.1-MeV doublet are also compared with the predictions of the impulse approximation. (auth)

33978 $^{12}C(\bar{p},\bar{p}n)^{11}C$, $^{12}C(\pi^{-},\pi^{-}n)^{11}C$, AND $^{19}F(\pi^{-},\pi^{-}n)^{18}F$ CROSS SECTIONS AT 2.5 GeV/c. Thompson, S. O.; Husain, L.; Katcoff, S. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 3: 1538-40(Apr 1971).

The cross section for the $^{12}C(\bar{p},\bar{p}n)^{11}C$ reaction measured at 1.73 GeV is 28.2 ± 3.6 mb, a value virtually identical with that of the corresponding proton-induced reaction (27.5 ± 0.6 mb). The $^{12}C(\pi^{-},\pi^{-}n)^{11}C$ and $^{19}F(\pi^{-},\pi^{-}n)^{18}F$ cross sections at 2.36 GeV are 19.4 ± 1.5 and 16.0 ± 2.0 mb, respectively. Each is about 25% lower than the corresponding reaction induced by 2.4-GeV protons. These results are discussed in terms of the free-particle cross sections. (auth)

33979 MEASUREMENT OF MAGNETIC-SUBSTATE POPULATIONS FOLLOWING THE REACTIONS $^{16}O(^{7}Li,t)^{20}Ne$ AND $^{16}O(^{6}Li,d)^{20}Ne$. Balamuth, D. P. (Univ. of Pennsylvania, Philadelphia). Phys. Rev., C; 3: 1565-9(Apr 1971).

Particle–γ angular correlations using the reactions $^{16}O(^{7}Li,t\gamma)^{20}Ne$ and $^{16}O(^{6}Li,d\gamma)^{20}Ne$ were measured. The populations of the various magnetic substates in the residual nucleus are extracted from the data. The results indicate the presence of other reaction mechanisms competing with direct transfer of an α particle. (auth)

33980 QUASIELASTIC ELECTRON SCATTERING AND PION ELECTROPRODUCTION FROM ^{12}C. Stanfield, K. C.; Canizares, C. R.; Faissler, W. L.; Pipkin, F. M. (Harvard Univ., Cambridge, Mass.). Phys. Rev., C; 3: 1448-65(Apr 1971).

Measurements of the electron–carbon scattering cross section at incident energies of 1, 1.5, 2.25, 3, and 4 GeV and at lab angles of 8.5, 12, and 18° are reported. The measurements included quasi-elastic scattering and inelastic scattering through the region of the first pion–nucleon resonance. The data are compared with a spectrum generated by summing the known elastic cross section, the known cross sections for excitation of nuclear levels, and a theoretical expression for quasi-elastic scattering based on the Fermi model for the nucleus. The agreement is satisfactory. The meson electroproduction cross section is derived by subtracting the above calculated spectrum from the data. The total equivalent photoabsorption cross section is consistent with the cross section expected for 12 independent nucleons; the existing Fermi-model calculation does not, however, correctly predict the shape of the electron momentum spectrum. The data are also used to test the Drell-Schwartz sum rule. (auth)

33981 PHENOMENOLOGICAL WAVE FUNCTION OF ^{6}Li. Cheon, Il-Tong (Kyung Hee Univ., Seoul, Korea). Phys. Rev., C; 3: 1023-30(Mar 1971).

In the framework of the α-deuteron cluster model, the J = 1 deformation is considered in the phenomenological wave function of ^{6}Li so as to produce the charge form factor and the quadrupole moment at the same time. In the model the deviation from the S state of the relative motion between the α particle and the deuteron compensates the quadrupole moment of the free deuteron, $Q_d^{exp} = +0.278 \pm 0.008$ fm^2, to give that of ^{6}Li, $Q_{Li}^{exp} = -0.08 \pm 0.008$ fm^2. It is shown that the quadrupole contribution plays an important role in filling up the diffraction minimum around $q^2 = 8$ fm^{-2} in the elastic charge form factor. (auth)

33982 SEARCH FOR EXCITED STATES OF ^{6}He. Stokes, Richard H.; Young, P. G. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C; 3: 984-91(Mar 1971).

The excitation spectrum of ^{6}He was examined through measurements of charged-particle energy spectra from four nuclear reactions. Triton energies up to 22 MeV were used to induce the $^{7}Li(t,\alpha)^{6}He$, $^{4}He(t,p)^{6}He$, and $^{6}Li(t,^{3}He)^{6}He$ reactions. Deuterons of 16- and 22-MeV energy were used to induce the $^{7}Li(d,^{3}He)^{6}He$ reaction. All of the energy spectra show peaks from the ^{6}He ground and first excited (1.80-MeV) states, but no other structure attributable to states of ^{6}He was observed. Differential cross-section data for the ground and first excited states were obtained for three of the reactions. The $(d,^{3}He)$ cross-section data were compared with the results of distorted-wave Born-approximation calculations and with data collected from the $^{11}B(d,^{3}He)^{10}Be$ reaction. These comparisons were consistent with an assignment of 2^{+} for the ^{6}He 1.80-MeV state. (auth)

33983 EFFECTS OF THE GIANT RESONANCE ON THE ENERGY SPECTRA OF NEUTRONS EMITTED FOLLOWING MUON CAPTURE IN ^{12}C AND ^{16}O. Plett, Michael E.; Sobottka, Stanley E. (Univ. of Virginia, Charlottesville). Phys. Rev., C; 3: 1003-10(Mar 1971).

The spectra of neutrons emitted following muon capture in carbon and oxygen are presented with a resolution of 6.5% at 5 MeV and a precision of 5%. The carbon spectrum is dominated by a broad peak at 4.2 MeV, while the oxygen spectrum is dominated by a narrower peak at 5.1 MeV. Partial transition rates for these two peaks are given. This structure supports theoretical predictions of the excitation of the giant resonance in the capture process. (auth)

33984 ISOSPIN SPLITTING IN THE GIANT RESONANCE OF ^{11}B. Patrick, B. H.; Medicus, H. A.; Mehta, G. K.; Bowey, E. M.; Gayther, D. B. (Atomic Energy Research Establishment, Harwell, Eng.). Phys. Lett.; 34B: 488-90(29 Mar 1971).

The giant dipole resonance of ^{11}B is shown to consist mainly of $T = \frac{1}{2}$ states in the lower energy region and $T = \frac{3}{2}$ states in the higher energy region by observing de-excitation γ-rays in the $^{11}B(\gamma,^{n}_{p}\gamma')$ reactions. (auth)

33985 PROTON STRIPPING STRENGTHS FOR LEVELS OF ^{11}C. Comfort, J. R.; Fortune, H. T.; Maher, J. V.; Zeidman, B. (Argonne National Lab., Ill.). Phys. Rev., C; 3: 1086-94(Mar 1971).

States of ^{11}C were studied with the $^{10}B(^{3}He,d)^{11}C$ reaction at a bombarding energy of 21 MeV. The data were found to favor the assignments $J^{\pi} = \frac{1}{2}^{+}$ and $\frac{5}{2}^{+}$ to the levels at 8.65 and 8.69 MeV, respectively. A distorted-wave analysis of the angular distributions for negative-parity states in ^{11}C yielded spectroscopic factors whose relative values agreed well with the predictions of Cohen and Kurath, even though the excited-state energies were found to be in better agreement with the predictions of the unified rotational model. (auth)

33986 TIME-REVERSAL INVARIANCE IN THE REACTIONS $^{16}O(d,\alpha)^{14}N$ AND $^{14}N(\alpha,d)^{16}O$. Thornton, S. T.; Jones, C. M.; Bair, J. K.; Mancusi, M. D.; Willard, H. B. (Oak Ridge National Lab., Tenn.). Phys. Rev., C; 3: 1065-86(Mar 1971).

An experiment to study time-reversal invariance by both absolute and relative tests of detailed balance in the reaction $^{16}O(d,\alpha)^{14}N$ and its inverse was performed. Measurements were made at three different excitation energies in a region where compound-nuclear resonances are resolved but overlapping levels are involved. In all cases the results are consistent with the principle of detailed balance, and the lowest uncertainty was ±0.5%. By making reasonable assumptions, an upper limit of 0.2% was assigned to the time-reversal-noninvariant part of the reaction amplitudes. (auth)

33987 REGGE POLES AND STRONG ABSORPTION IN HEAVY-ION AND α-NUCLEUS SCATTERING. McVoy, K. W. (Argonne National Lab., Ill.). Phys. Rev., C; 3: 1104-17(Mar 1971).

Regge poles describing shape resonances (quasimolecular states) are found to play a prominent role in many optical-model scattering amplitudes and appear to be directly related to the Gruhn–Wall "dip" often observed in the reflection coefficient $\eta(l)$. The Blair smooth-cutoff model is generalized to include such a Regge pole and used to fit angular distributions for elastic $^{16}O + ^{16}O$ and $\alpha + ^{16}O$ scattering, in the 20–30-MeV (c.m.) energy range. It also appears that the smooth-cutoff (strong-absorption) model itself can be interpreted as the result of many overlapping inelastic Regge resonances. (auth)

33988 MICROSCOPIC STRUCTURE OF THE ^{12}C GIANT RESONANCES. Brassard, Joseph Jean Claude. New Haven; Yale Univ. (1970). 472p. University Microfilms Order No. 71-2485.

Thesis.

A comprehensive study, involving the development of a number of new techniques, both experimental and theoretical, was carried out on the proton radiative capture reactions leading to the first four states in ^{12}C. Excitation functions were extended to 36 MeV, through the previously inaccessible excitation energy range, utilizing the MP tandem accelerator and the on-line data acquisition system. Microscopic R-Matrix calculations, utilizing the one-particle one-hole wave functions of Gillet were compared not only with these data, but also with the gamma radiation angular distributions measured systematically throughout the energy range studied; it was necessary to evolve an internally consistent technique for carrying out these calculations, inasmuch as detailed study has revealed that none had existed previously. Measurements reported herein strongly suggest that for certain instrumental reasons, all the previously reported absolute cross sections for high energy radiative capture reactions (i.e., above 10 MeV excitation) were overestimated by as much as 50%. This has important consequences concerning the isospin purity arguments. Apart from this, while the theoretical predictions reproduce both the excitation functions and angular distributions of the gamma radiation to the ^{12}C ground state remarkably well, it was found that the Gillet wave functions do not constitute a significant improvement over pure j–j configurations in this respect. Gross discrepancies between the absolute magnitude of the predicted and experimental cross sections to the excited states in ^{12}C (far exceeding the 50% mentioned above) suggest that more complex configurations, primarily two-particle, two-hole, in nature play a dominant role. The data support the view that capture to the 4.43 MeV state involves a giant dipole based on that state in analogy with the dipole resonance based on the ground state. The capture cross section to the 3^{-} state at 9.63 MeV in ^{12}C shows that this state involves relatively little one-particle one-hole structure. As an integral part of the instrumental development involved in these measurements a new electronic system capable of counting some forty times faster than any previously reported, on-line gain control and pile up monitoring, and on-line data analysis capabilities were demonstrated. (Diss. Abstr. Int., B)

33989 ^{6}Li(α,2α)d REACTION AT 50 TO 80 MeV. Watson, John Woolman. College Park, Md.; Univ. of Maryland (1970). 186p. University Microfilms Order No. 71-4932.

Thesis.

The ^{6}Li(α,2α)d reaction was studied at 50.4, 59.0, 60.5, 70.3 and 79.6 MeV bombarding energy. Coincident energy spectra of the two emitted α-particles were measured. Special emphasis was placed on measuring spectra at pairs of angles where zero momentum (in the laboratory frame of reference) was possible for the residual deuteron. The projected energy spectra were analyzed with the Plane Wave Impulse Approximation. From those points in the projected spectra which corresponded to zero deuteron recoil momentum, off-mass-shell $\alpha-\alpha$ scattering cross sections were extracted. Predictions of off-mass-shell $\alpha-\alpha$ cross sections were made using a potential model. These indicate that the off-mass-shell cross section should indeed be very similar to the on-mass-shell cross section at the final state energy. Using the Plane Wave Impulse Approximation a momentum distribution for α's in ^{6}Li was extracted from the experimental data. A cluster model for ^{6}Li was devised to fit the binding energy and r.m.s. charge radius of ^{6}Li, as well as the $^{3}S_{1}$ α-d scattering phase shift. For comparison with the experimental data, the momentum wave function of the α-particle in ^{6}Li was calculated by taking the Fourier transform of the α-d relative motion. The theoretical and experimental momentum distributions were found to be in serious disagreement, both in magnitude and width at half maximum. By introducing a cut-off radius into the theoretical wave function, the discrepancies between theory and experiment were accounted for. It was also found, that if the cut-off radius is used as an adjustable parameter, then this ^{6}Li wave function and reaction model explains the magnitudes and widths of the α-d relative momentum distributions determined from a wide variety of other reactions. (Diss. Abstr. Int., B)

33990 PARTICLE-HOLE DIPOLE STATES IN ^{16}O. Garside, Leonard. College Park, Md.; Univ. of Maryland (1966). 88p. University Microfilms Order No. 71-4025.

Thesis.

A unified nuclear reaction theory is applied to the study of the five particle-hole dipole states in ^{16}O. These states, two of which are associated with the giant dipole resonances, are formed by coupling a $2S\frac{1}{2}$, 1d3/2 or 1d5/2 particle to a $1p\frac{1}{2}$ or 1;3/2 hole, to give J = 1, T = 1 and odd parity. One of these states (the 1d3/2 neutron or proton state) has been observed experimentally as a particle resonance in the continuum, and so can not be treated as a bound shell-model state without further modification. The depth of a model nuclear potential is adjusted so that this state is actually bound, and then the residual one-body potential is added to the interaction potential. As a further step in the investigation it was necessary to evaluate particle hole matrix elements and level widths of the dipole states. The calculated widths are in satisfactory agreement with experiment. The effect, upon the energy eigenvalues, of damping due to nucleon emission is investigated. Contrary to the expectation of many theorists, the eigenvalues were shifted by a negligible amount (less than 40 keV). The energy dependence of level shifts caused by variation in the real part of the effective interaction itself with energy was studied. It is concluded that unless the effective interaction, implicitly or explicitly, includes this interaction between discrete states and continuum, large energy shifts, resulting from this coupling, completely invalidate usual shell-model calculations of resonance energies. In the implicit case one would expect the effective interaction to be strongly state dependent and therefore vary from nucleus to nucleus. (Diss. Abstr. Int., B)

33991 ELECTROEXCITATION OF THE ^{12}C GIANT RESONANCE. Lightbody, John Wesley Jr. College Park, Md.; Univ. of Maryland (1970). 222p. University Microfilms Order No. 71-4072.

Thesis.

An electron scattering experiment to measure the transverse and longitudinal form factors for ^{12}C in the excitation interval 17-37 MeV was performed. Levels at 17.25, 18.15, and 19.4 MeV and fine structure in the giant resonance region ($\omega > 20$ MeV) were observed. Measurements were done at scattering angles of 75°, 127.5°, and 145°, and with incident beam energies such that the same momentum transfers (q) were obtained at several angles. Such measurements permit the separation of transverse

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and longitudinal form factors. The q-range for which this separation was made was from .35 to .84 fm^{-1}. Reduced transverse and longitudinal matrix elements for subintervals in the 17-37 MeV region are presented as well as comparisons with particle-hole model, liquid drop model, and quasi-elastic model calculations. Transverse matrix elements are compared with other results obtained using 180° electron scattering apparatus, however no other data for longitudinal reduced matrix elements exists with which to compare the present data. Total angular momentum assignments for the 17.25, 18.15 and 19.4 MeV levels are made on the basis of the q-dependences of the reduced matrix elements. The giant dipole resonance, centered at about 22-23 MeV excitation, is observed to have fine structure similar to the predictions of Nilsson, Sawicki, and Glendenning, and of Überall and Kelly. However, the lack of prominence of this fine structure prevents any more detailed analysis than simply comparing the integrated cross-section in several excitation intervals with the available theoretical models. The quasi-elastic calculations of deForest in fact gave better agreement with measured transverse and longitudinal reduced matrix elements than specific particle-hole model or liquid drop model calculations for the giant resonance. The present data was integrated over the experimentally available excitation energies at constant q, and compared with sum rule calculations for the total inelastic longitudinal and transverse excitation strength. Comparison shows excellent agreement for both terms over the measured q-range. Furthermore the complete calculation done here is considerably larger than the electric dipole sum rule of Czyz except at lowest q, where the two coalesce. It is interesting to observe that the transverse and longitudinal sums are simply and directly related to the nucleon-nucleonpair correlation function. Theoretical radiation tails for elastic electron scattering, which went into analysis of the present data, seem to be accurate to at least 40 MeV excitation. Questions concerning the validity of radiative corrections to the scattering process are raised, insofar as they affect the shape of the radiation tail near the scattering peak. (Diss. Abstr. Int., B)

33992 STUDY OF PHOTONEUTRONS FROM ^{16}O, ^{12}C, AND ^{9}Be. Glavina, Corrado. Saskatoon; Univ. of Saskatchewan (1969). 82p. University Microfilms Order No. 71-3207.

Thesis.

Photoneutron spectra and angular distributions from ^{16}O, ^{12}C, and ^{9}Be produced by $E_{\gamma max}$ = 103 MeV bremsstrahlung were measured. The spectra were obtained simultaneously at five angles by the time-of-flight technique. In the low energy region (En < 15 MeV), corresponding to the giant resonance region of these nuclei, the energy of the major resonances observed in ^{12}C and ^{16}O agrees with previous measurements. The angular distributions indicate that neutrons are primarily due to d-wave emission. The neutron spectrum from ^{9}Be shows no structure. The spectra of neutrons of En > 15 MeV show no structure for all nuclei investigated. The 90° yield decreases nearly exponentially with increasing energy. Neutrons are emitted preferentially at angles forward of 90° with respect to the incident photon direction. This forward peaking of the angular distribution is interpreted as being due to absorption of photons by clusters of nucleons in the nucleus. (Diss. Abstr. Int., B)

33993 ELECTROMAGNETIC DECAY OF STATES OF HIGH SPIN AND HIGH ISOSPIN IN ^{19}F. Aitken, James Henry. Toronto; Univ. of Toronto (1969). Available from National Library of Canada at Ottawa.

Thesis.

The lowest $J^\pi = 11/2^+$ state and the lowest two $T = 3/2$ states in ^{19}F were located among a number of new resonances in the ^{15}N $(\alpha,\gamma)^{19}$F reaction. The spins and radiative widths of these three new levels were established by measurements of angular distribution and yield of γ-radiation. Their isospin is inferred from their spins, excitation energies, radiative widths and decay schemes. Measured transition matrix elements are compared with those calculated from shell-model wavefunctions which include all $(sd)^3$ configurations. Disagreements between experiment and theory indicate that the $(sd)^3$ description is inadequate for some of the positive parity states in ^{19}F above about 4 MeV in excitation. Arguments are presented for the inclusion of $(p)^{-2}$ $(sd)^5$ configurations to account for the properties of these states. The new $11/2^+$ level and the $7/2^+$ level at 4.38 MeV (whose spin has been definitely established in the course of this work) are discussed also in terms of a simple adiabatic rotational model for ^{19}F. This model is found to account reasonably well for the excitation energies and transition probabilities of the lowest levels of spins 1/2 to 13/2. (Diss. Abstr. Int., B)

33994 EXCITATION FUNCTIONS OF PROTON-INDUCED REACTIONS IN ^{16}O AT MEDIUM ENERGIES. Bunker, S. N.; Appel, H.; Cameron, J. M.; (and others) (Univ. of California, Los Angeles). Nucl. Phys.; A163: 378-400(1971).

Protons elastically and inelastically scattered from ^{16}O were observed at lab angles between 60 and 160° using NaI(Tl) detectors. The incident beam energy was varied in approximately 200 keV steps from 21.25 to 33.12 MeV and in 500 keV steps at higher energies up to 38.5 MeV. Angular distributions at the same energies were also measured for inelastic proton scattering leaving the ^{16}O nucleus with excitation energies of Q = −6.05, −6.13 MeV and Q = −8.88 MeV. The excitation functions for the (p,d) and (p,α) reactions were measured at 70° for the same energy range, and the (p,t) reaction was observed above 31 MeV. The elastic scattering angular distributions were integrated over the angular range 100−160° and anomalies are observed. An optical-model-with-resonance analysis of the data is presented which indicates states at E_p = 21.6, 22.6, 23.5, 24.7, 26.4, 28.3 and 30.1 MeV with J^π assignments $3/2^+$, $3/2^+$, $1/2^+$, $1/2^+$, $1/2^-$, $5/2^-$ and $5/2^+$, respectively. A coupled-channels calculation has also been compared with the elastic and inelastic scattering (Q = −6.05, −6.13 MeV) angular distributions. (auth)

33995 STUDY OF THE ^{19}F(^{3}He,^{6}Li)^{16}O REACTION AT 11 MeV. Strohbusch, U.; Schmidt, W.; Huber, G. (Univ., Freiburg i. B.). Nucl. Phys.; A163: 453-64(1971).

Angular distributions of the ^{19}F(^{3}He, ^{6}Li)^{16}O reaction were measured at 11 MeV for the transitions $^{6}Li_{g.s.}(^{16}O_{g.s.})$, $^{6}Li_{3.56}$ $(^{16}O_{g.s.})$ and $^{6}Li_{g.s.}(^{16}O_{g.s.06.6.14})$. Zero-range DWBA analysis on the basis of the triton pickup mechanism revealed good fits for the two transitions to $^{16}O_{g.s.}$. A ratio of 1.6 ± 0.2 is obtained for the spectroscopic factors $S(^{6}Li_{g.s.}|^{3}He, t)$ and $S(^{6}Li_{3.56}|$ $^{3}He, t)$. Published angular distributions of the reaction ^{19}F(p,α) ^{16}O for E_p = 22.8 and 30.5 MeV were analyzed on the basis of the same mechanism using the same triton well geometry as for the (^{3}He, ^{6}Li) calculations and yield a spectroscopic factor $S(^{19}F|$ $^{16}O,t)$ = 0.06. A rather strong transition $^{19}F(^{3}He, ^{6}Li_{g.s.})^{16}O_{g.06.6.14}$ is observed which is not compatible with one-step triton pickup. The corresponding angular distribution shows no pronounced structure. (auth)

33996 PRODUCTION OF FAST DEUTERONS FROM THE INTERACTION OF HIGH-ENERGY PROTONS WITH NUCLEI. Balashov, V. V.; Markov, V. I. (Moscow State Univ.). Nucl. Phys.; A163: 465-77(1971).

An analysis of the experimental data on the production of fast deuterons from the interaction of high-energy protons with carbon is made within the framework of the impulse approximation and under the assumption of a surface reaction mechanism. Single-particle and cluster aspects of nuclei are investigated on the basis of the many-particle approach. (auth)

33997 HIGH-ENERGY PHOTONEUTRONS FROM ^{12}C. Miller, H. G.; Buss, W.; Rawlins, J. A. (Saskatchewan Accelerator Lab., Saskatoon). Nucl. Phys.; A163: 637-48(1971).

Photoneutron spectra from the reaction $^{12}C(\gamma,n)^{11}C$ were measured at bremsstrahlung end-tip energies from 64 to 128 MeV in 2 MeV steps. The spectra were obtained simultaneously at five angles (30°, 60°, 90°, 112° and 142°) using time-of-flight techniques. The measured cross sections for a fixed neutron energy exhibit kinematic resonances corresponding to the emission of a single neutron from the 1p shell in ^{12}C. The observed angular distributions of these 1p shell neutrons are forward asymmetric, the asymmetry increasing with neutron energy. The results are compared with single-particle and cluster theories. It was found that the angular distributions and the differential cross section at 90° can best be explained by a quasi-alpha model. It is therefore concluded that dynamic correlations between nucleons in the same shell are more important than those between nucleons in different shells. (auth)

33998 MANY-NUCLEON TRANSFER REACTIONS OF PROTONS WITH ^{12}C AND ^{13}C AT 45.0 MeV. Bray, K. H.; Jain, Mahavir; Jayaraman, K. S.; (and others) (Univ. of Manitoba, Winnipeg). Nucl. Phys.; A163: 649-60(1971).

Differential cross sections for the $^{12}C(p,^{6}Li)^{7}Be$, $^{13}C(p,^{6}Li)^{8}Be$, $^{13}C(p,^{6}Li)^{8}Be^*$ (2.90 MeV), and $^{13}C(p,^{7}Li)^{7}Be$ reactions were measured at an incident proton energy of 45.0 MeV. The measurements extend for the most part over laboratory angles from 15° to 80°. The cross sections for all the reactions are found to be very small and are of the order of 10μb. Nevertheless, for ^{13}C the six-nucleon transfer reaction has a cross section about 5 times that of the five-nucleon transfer reaction. The angular distributions were analyzed using a distorted-wave Born approximation (DWBA) theory assuming the presence of lithium clusters in the target nuclei. (auth)

33999 LEVELS OF ^{15}O OBSERVED IN THE ^{12}C(^{3}He,n)^{15}O REACTION. Hinderliter, H. F.; Lochstet, W. A. (Pennsyl-

vania State Univ., University Park). Nucl. Phys.; A163: 661-72 (1971).

Angular distributions were measured for the reaction ^{13}C (^3He,n)^{15}O at 6 MeV, for angles up to 160° (lab), and excitation energies up to 9.66 MeV. The results were compared with DWBA calculations, and spectroscopic factors were obtained. (auth)

34000 INVESTIGATION OF REACTION Li + Li AND POSSIBLE EXISTENCE OF THREE-CLUSTER STATES. Glukhov, Yu. A.; Novatskii, B. G.; Ogloblin, A. A.; (and others) (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 277-82(Feb 1971). (In Russian).

The reactions (^{6}Li, α) and (^{7}Li, α) are studied on ^{6}Li and ^{7}Li targets at E^6Li = 26 MeV and E^7Li = 30 MeV. An intensive level excitation near the three-particle thresholds $^6Be \rightarrow \alpha + d + d$, $^9Be \rightarrow \alpha + t + d$, $^{10}Be \rightarrow \alpha + t + t$ is observed. It seems that to some of these states a three-cluster structure can be assigned. (auth)

34001 NUCLEAR STRUCTURE OF ^{6}Li AND HIGH-ENERGY ELECTRON SCATTERING. Lodhi, M. A. K. (Texas Technological Univ., Lubbock, Tex. Univ., Frankfurt am Main). Z. Naturforsch.; 26a: 224-7(Feb 1971).

The nuclear charge form factor from the high-energy elastic electron scattering on ^{6}Li is calculated from the modified independent-particle-shell-model (IPSM) wave function. The usual harmonic-oscillator-type IPSM wave function is modified by the inclusion of a nucleon–nucleon correlation function that involves extra-core nucleons only. The technique is extremely simple, and provides an excellent agreement with the experimental data. (auth)

34002 EMISSION OF HEAVY PARTICLES IN REACTION A(π,πK)B ON LIGHT NUCLEI AT THE π^+-MESON ENERGY OF 112 MeV. Gismatullin, Yu. R.; Ostroumov, V. I.; Plyushchev, V. A. (Leningrad Polytechnic Inst.). Yadern. Fiz.; 13: 291-2 (Feb 1971). (In Russian).

Reactions A(π^+,π^+K)B and A(π^+,π^0K)B are investigated in an experiment where deuterons or α particles are detected as the K particles. The results are compared with data of other works. It is shown that emission of α particles may be described in the framework of the pole approximation. (auth)

34003 INVESTIGATION OF MANY-PARTICLE REACTIONS WITH PRODUCTION OF ^{8}Li AT CAPTURE OF STOPPING π^- MESONS BY ^{12}C NUCLEI. Agababyan, N. M.; Batusov, Yu. A.; Bunyatov, S. A.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 283-90(Feb 1971). (In Russian).

Three-, four-, and five-particle reactions with production of ^{8}Li in capture of π^- mesons by ^{12}C were investigated by means of photoemulsion chambers. Relative probabilities of various channels of the reactions were determined. Energy spectra and angular correlations of the secondary particles are measured for the reaction $\pi^- + {}^{12}C \rightarrow {}^8Li + {}^2H + {}^1H + n$. On the basis of the experimental results and of theoretical calculations in the framework of the direct nuclear reaction theory, the conclusion is drawn that for production of ^{8}Li on C the most essential contribution is from capture of π^- by the four-nucleon association ^{4}Li. (auth)

34004 EXPERIMENTAL INVESTIGATION OF $^{16}O + {}^{12}C$ NUCLEAR BURNING AT STELLAR ENERGIES. Patterson, J. R. (Univ. of Adelaide); Nagorcka, B. N.; Symons, G. D.; Zuk, W. M. Nucl. Phys.; A165: 545-59(1971).

The $^{12}C(^{16}O,\alpha)^{24}Mg$ and $^{12}C(^{16}O,p)^{27}Al$ reactions were studied for c.m. energies from 4.54 to 8.53 MeV to provide experimental data on their cross sections in the region of astrophysical interest. Excitation functions and angular distributions were measured and are used to estimate the total and partial reaction cross sections for energies down to 3 MeV at which $^{16}O + {}^{12}C$ nuclear burning is expected to be important in stars. The cross sections for these reactions show a pronounced resonance structure similar to that found in the $^{12}C + {}^{12}C$ system. These "quasi-molecular" resonances are grouped just below the Coulomb barrier energy and do not appear to extend below 6 MeV in the $^{12}C + {}^{16}O$ system. (auth)

34005 PROTON EMISSION MECHANISM IN 112 MeV π^+ MESON EXCHANGE SCATTERING OF LIGHT NUCLEI. Gismatullin, Yu. R.; Ostroumov, V. I.; Plyushchev, V. A. (Leningrad Polytechnic Inst.). Yadern. Fiz.; 13: 478-83(Mar 1971). (In Russian).

π^+ meson charge exchange on nuclei accompanied by one-proton emission (the reaction A(π^+,π^0p)B) with the mean meson energy 112 ± 6 MeV was studied using the nuclear emulsion method. A detailed kinematic analysis of splittings and the check of applicability of the pole approximation by means of the Treiman–Yang criterion indicate the dominant contribution of the pole graph in the region of small momentum transfer. It is shown that the ratio $\sigma(\pi^+,\pi^+p)/\sigma(\pi^+,\pi^0p) = 1.76 \pm 0.15$ cannot be explained by the model of the coherent exchange scattering of π^+ mesons on nuclei. (auth)

34006 INVESTIGATION OF PROTON AND DEUTRON SPECTRA FROM PHOTODISINTEGRATION OF NUCLEI BY PHOTONS WITH THE MAXIMAL ENERGY UP TO 1200 MeV. Antuf'ev, Yu. P.; Agranovich, V. L.; Ganenko, V. B.; (and others) (Physical-Technical Inst., Kazan). Yadern. Fiz.; 13: 473-7(Mar 1971). (In Russian).

Photoproton and photodeuteron energy spectra in the kinetic energy region 30–400 and 30–200 MeV, respectively, are given. Maximal energy of the bremsstrahlung interacting with the Li, Be, C, Si, Cu, Ta, Pb nuclei was 700 and 1200 MeV. For the ^{12}C nucleus the proton spectra measured are compared with the calculation ones according to the photomeson and quasi-deuteron mechanism models of the proton photoproduction. Deuteron to proton production differential cross section ratios are obtained depending on the mass number of the nucleus-target, momentum and energy of secondary particles at different angles. (auth)

34007 INTEGRAL CHARACTERISTICS OF THE GIANT RESONANCE AND TRANSITION RADII OF NUCLEI WITH A ≤ 60. Gul'karov, I. S. (Tashkent Polytechnic Inst.). Yadern. Fiz.; 13: 321-5(Feb 1971). (In Russian).

Analysis of the giant resonance form factors for ^{12}C, ^{28}Si, ^{32}S, and ^{60}Ni on the basis of phenomenological models and of the liquid drop model enables one to determine the reduced transition probabilities, the transition radii, and the vibrational parameters of the nuclei. Simple empirical formulas are obtained that describe the observed A dependence of the integral characteristics of the giant resonance. The vibrational parameters are compared with the predictions of the dynamical collective theory. Some regularities are found in the behavior of the transition radii. (auth)

34008 INVESTIGATION OF ONE-NUCLEON TRANSFER REACTIONS BETWEEN COMPLEX NUCLEI AT INCIDENT ENERGIES BETWEEN 3 MeV/NUCLEON AND 8 MeV/NUCLEON. Liu, M.; Von Oertzen, W.; Jacmart, J. C.; (and others). (Institut de Physique Nucleaire, Orsay, France). Nucl. Phys.; A165: 118-28(1971).

Angular distributions of the ground state transitions in the reactions $^{11}B(^{14}N,^{15}O)^{10}Be$, $^{11}B(^{14}N,^{13}C)^{12}C$, $^{12}C(^{11}B,^{12}C)^{11}B$, and $^{13}C(^{12}C,^{13}C)^{12}C$ have been measured with a magnetic spectrometer as an identification system. The first two reactions (angular momentum transfer l = 2) measured at 41, 77 and 113 MeV show a clear damping of the oscillatory structures in the angular distributions. This effect was qualitatively reproduced by DWBA calculations which take into account a recoil phase, thus showing that the damping of the structures is due to the recoil of the transferred particle on the system. The reaction $^{11}B(^{12}C,^{11}B)^{12}C$ (l = 2) at 87 MeV with Q = 0 is well reproduced by the calculations, whereas the $^{13}C(^{12}C,^{13}C)^{12}C$ reaction as the only l = 0 transition is in complete disagreement with theoretical expectations. (auth)

34009 ASYMMETRY MEASUREMENTS FOR THE REACTION $^{10}B(p,d)^9B$ INDUCED BY POLARIZED PROTONS. Squier, G. T. A. (Queen's Univ., Belfast); Johnston, A. R.; Megaw, J. H. P. C.; Griffiths, R. J.; Kingston, F. G. Nucl. Phys.; A167: No. 3, 465-9(1971).

The analyzing powers of the reaction $^{10}B(p,d)^9B$ have been measured for the ground state and 2.33 MeV level of ^{9}B in the angular range 23° to 100° c.m. The results are compared with DWBA calculations. (auth)

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Refer also to abstracts 33521, 33954, 33969, 33974, 34006, 34007, 34075, 34077–34079, 34081, 34082, 34130, 34136, 34141, 34143, 34144, and 34192.

34010 (KFKI–71-14) GAMMA–GAMMA ANGULAR CORRELATION MEASUREMENTS IN THE $^{59}Co(n,\gamma)^{60}Co$ REACTION. Kardon, B.; Kiss, D.; Seres, Z. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [nd]. 6p. Dep. NTIS (U. S. Sales Only).

Angular correlation measurements of gamma radiation following thermal neutron capture in ^{59}Co have been performed with a combination of a 10 ccm Ge(Li) diode and a 12.7 × 12.7 cm NaI(Tl) detector. In the decay of ^{60}Co, cascades of 6876.6 – 555.7 keV and 6984.6 – 447.2 keV were observed. The spins and parities of the 605 and 613 keV levels were found to be 3^+. (auth)

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34011 (NP-18812) PROBABILITIES OF ELECTROMAGNETIC TRANSITIONS IN ^{41}Ca. Laurent, Henri (Paris Univ., Orsay (France). Faculte des Sciences). 5 Feb 1971. 64p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis.

The lifetimes of eight levels of ^{41}Ca excited in the reactions ^{41}K(p,n) up to 4.3 MeV and ^{40}Ca(d,pγ) between 3.75 and 4 MeV were measured, and the limits are given for four other levels. The method of Doppler effect attenuation was used. The accuracy is about 25 percent for lifetimes between 2×10^{-14} and 5×10^{-13} s. The experimental results are compared to those obtained from various existing models (the Gerace and Green model, the Federman model for negative parity levels, the Dieperinck and Brussaard model for positive parity levels). The comparison confirms the image of an almost full core for ^{40}Ca. The excitation of many particles in the ^{40}Ca core must be taken into account if the various characteristics of the ^{41}Ca levels are to be explained. (France)

34012 SELF-CONSISTENT CALCULATIONS FOR EVEN Ti, Cr, AND Fe ISOTOPES. Chandra, Harish; Rustgi, M. L. (State Univ. of New York, Buffalo). Phys. Rev., C; 3: 1476-87(Apr 1971).

Results of self-consistent calculations with Hartree–Fock (HF), Hartree–Fock–Bogolyubov (HFB), and spherical BCS approximations obtained with the central Yukawa (CY) interaction and with renormalized Kuo–Brown matrix elements for the Hamada–Johnston (HJ) interaction are reported for even Ti, Cr, and Fe isotopes. The calculated ground-state energies, corrected for Coulomb interactions among the extracore protons, are compared with the experimental values; and a better agreement for the HJ interaction is obtained than for the CY, although they do not differ much. It is found that, in the HFB approximation, the HJ interaction favors prolate solutions over oblate or spherical ones. Unlike the CY, the HFB approximation for Z < N = 28 nuclei with the HJ interaction does not converge to spherical minima with lowest energy. It is also seen that the pairing contribution to the spherical BCS energy minimum is considerably larger for the HJ interaction as compared to the CY. The desirability of spherical solutions for Z > N = 28 nuclei for the HJ interaction is discussed, and it is argued that it cannot be obtained by including n–p pairing in the T = 1 state. Modification of the Kuo–Brown renormalized matrix elements is suggested. Results for the oblate and prolate HFB solutions for ^{58}Fe with HJ interactions are discussed, as these solutions have very close energy minima. (auth)

34013 EFFECTIVE-INTERACTION THEORY OF NUCLEAR SPECTRAL RELATIONS. II. Goode, Philip; Koltun, Daniel S.; West, Bruce J. (Univ. of Rochester, N. Y.). Phys. Rev., C; 3: 1527-37(Apr 1971).

A theory of particle–hole relations among spectra, presented in Part I [Phys. Rev., 187: 1315(1969)], is extended to include hole–hole (hh) spectra as well as the particle–particle (pp) and particle–hole (ph) cases previously treated. This theory, which incorporates configuration mixing into many-body effective interactions, goes beyond the simple shell-model particle–hole relations of Pandya, Goldstein, and Talmi. A new shell-model relation involving all three partners (the triptych: pp, ph, and hh) is derived. The many-body theory and the triptych relation are applied to the nuclei ^{42}Sc, ^{48}Sc, and ^{54}Co, which are partners in the $f_{\frac{7}{2}}$ shell. The spectra of these nuclei can be related with considerably greater accuracy than with the standard shell-model relations. (auth)

34014 MICROSCOPIC ANALYSIS AND IDENTIFICATION OF UNNATURAL-PARITY STATES IN ^{58}Ni. Stautberg, M. M. (De Paul Univ., Chicago. Argonne National Lab., Ill.). Phys. Rev., C; 3: 1541-9(Apr 1971).

A microscopic analysis of the inelastic scattering of 17.7-MeV protons from ^{58}Ni is carried out. The angular distributions of the states at 2.900 MeV (J = 1), 3.414 MeV (J = 3), and 3.773 MeV (J = 3) are best characterized by L = 2, L = 2 + 4, and L = 2 distorted-wave (DW) curves, respectively. These combinations of J and L values identify these as unnatural-parity states. The microscopic analysis used Hamada–Johnston and Gaussian realistic interactions, a mixed-configuration ground state, and pure configurations for the excited states. Exchange effects were considered in an approximate way. Comparison of the DW curves with the data indicates that the $(p_{\frac{1}{2}}f_{\frac{7}{2}})$ configuration is predominant in the 2.900-MeV state. (auth)

34015 OPTICAL-MODEL ANALYSIS OF p + ^{40}Ca ELASTIC SCATTERING FROM 10 TO 180 MeV. van Oers, W. T. H. (Univ. of Manitoba, Can.). Phys. Rev., C; 3: 1550-9(Apr 1971).

An optical-model analysis is made of available p + ^{40}Ca elastic scattering data by using the 11-parameter automatic search code SEEK. The analysis includes cross-section and polarization angular distributions at 34 energies in the range 10 to 180 MeV. The available p + ^{40}Ca total-reaction-cross-section data are also used in the analysis. Emphasis is placed on determining the energy dependence of the optical-model parameters. When the higher-energy data, i.e., the data for incident proton energies greater than 100 MeV, are excluded, a common geometry for the optical potentials can be defined; consequently, the energy dependence is given entirely by the behavior of the strength coefficients of the various potential terms. The energy dependence of the real central potential for ^{40}Ca can be represented by $dV/dE \cong -0.30$. The fits to the experimental angular distributions are of the same quality or slightly better than those obtained in previous analyses. For some energy regions difficulties exist in fitting the large-angle data. The rms radius for the real-central-potential term is nearly constant over the entire energy range 10 to 75 MeV. The mean and standard deviation from the mean of the rms radius for the real central potential are 4.06 and 0.12, respectively. (auth)

34016 ELASTIC SCATTERING OF 30.3-MeV POLARIZED PROTONS FROM ^{40}Ca, ^{56}Fe, AND ^{59}Co. Hnizdo, V. (Univ. of Birmingham, Eng.); Karban, O.; Lowe, J.; Greenlees, G. W.; Makofske, W. Phys. Rev., C; 3: 1560-5(Apr 1971).

Results are presented for the elastic scattering of 30.3-MeV polarized protons from targets of ^{40}Ca, ^{56}Fe, and ^{59}Co. The angular region from 20 to 165° is covered with an absolute accuracy in the polarization measurements of about 0.01. The data, together with corresponding differential-cross-section data reported elsewhere, are analyzed using the optical model. The present results confirm the trends with mass number found earlier—present forms of the model may be satisfactory only for large nuclei (^{208}Pb); for lighter systems modifications may be needed. (auth)

34017 LOW-LYING EXCITED STATES OF ^{70}Ga AND ^{72}Ga POPULATED IN THERMAL-NEUTRON CAPTURE. Vervier, J. (CEN, Mol, Belgium); Bolotin, H. H. Phys. Rev., C; 3: 1570-84(Apr 1971).

The level structures of the odd–odd nuclei ^{70}Ga and ^{72}Ga were investigated by means of the thermal-neutron-capture reactions ^{69,71}Ga(n,γ)^{70,72}Ga. Capture γ-ray spectra from isotopically separated targets of ^{69,71}Ga were studied with Ge(Li) spectrometer systems between 4500 keV and the neutron binding energies and, for the ^{71}Ga target, between approximately 80 and 670 keV. The results of these investigations are compared with previous data, and good agreement is generally obtained. They have led to the construction of the decay scheme of low-lying states in ^{70,72}Ga and to the determination of the neutron binding energies 7651 ± keV for ^{70}Ga and 6519 ± 1 keV for ^{72}Ga. (auth)

34018 ANGULAR DISTRIBUTION OF NEUTRONS WITH INITIAL ENERGY OF 2,9 MeV SCATTERED BY MAGNESIUM NUCLEI. Fedorov, M. B.; Yakovenko, T. I. (Inst. for Nuclear Research, Kiev). Ukr. Fiz. Zh. (Russ. Ed.); 15: 1908-9(Nov 1970). (In Russian).

A time-of-flight method was used for studying the angular distributions of neutrons scattered by magnesium nuclei. Data were obtained for the initial mean energy of 2.86 MeV; moreover, according to the calculations, the energy of the incident neutrons was confined to the region of 2.75 to 2.95 MeV (FW.1M). Differential cross sections for elastic scattering and inelastic scattering to the first excited state of ^{24}Mg are analyzed. The measured integral cross sections nuclei are in good agreement with published data. (R.V.J.)

34019 EVIDENCE FOR E1–M2 AND M1–E2 MIXTURES IN HIGH-ENERGY γ-TRANSITIONS. Oliva, P. R. (CNEN, Rome). Lett. Nuovo Cim.; 1: 77-80(16 Jan 1971).

A direct measurement of the multipolarities of high-energy γ transitions in ^{112}Cd and ^{65}Cu was made through the determination of the angular distribution and the linear polarization of the γ rays leaving the excited nuclei. The excited states were prepared by electromagnetic resonance excitation using a γ-ray beam produced by neutron capture in Fe and Cr. Spin–parity assignments and multipole mixing ratios are given for the 7646-keV level in ^{112}Cd and the 8484-keV level in ^{65}Cu. The 7632-keV resonant level in ^{112}Cd was also investigated. (R.W.R.)

34020 (d,p) REACTION ON ^{20}Ne. Heikkinen, D. W. (Univ. of California, Livermore); Pixley, R. E. Phys. Rev., C; 3: 1696-8(Apr 1971).

The ^{20}Ne(d,p)^{21}Ne reaction was investigated at deuteron energies of 8.0, 12.0 and 14.0 MeV. Good agreement is obtained with recent results at E_d = 16.4 MeV for spectroscopic factors for the low-lying levels of ^{21}Ne. These indicate appreciable mixing among the rotational bands of ^{21}Ne. (auth)

34021 LEVELS IN ^{20}F NEAR 6-MeV EXCITATION ENERGY. Rollefson, A. A.; Aymar, J. A. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 3: 1704-6(Apr 1971).

Angular distributions and excitation energies were measured for two levels in ^{20}F previously reported at 5.87 and 5.95 MeV. Present results give energies of 5.932 ± 0.005 and 6.013 ± 0.005 MeV, in excellent agreement with γ-ray measurements. (auth)

34022 EXCITED LEVELS OF ^{38}K. Ronsin, Genevieve (Paris Univ., Orsay, France); Vergnes, Michel; Linck, Isabelle; Rotbard, Georges; Kalifa, Jacques. Compt. Rend., Ser. B: 272: No. 9, 542-4(1 Mar 1971). (In French).

Many excited levels of ^{38}K were studied with the reaction ^{39}K(^{3}He,α)^{38}K. Their parity and the possible values of the spin were found by studying the angular distributions. The spins and isospins are given for several levels. Two of them had never been observed before. (auth) (France)

34023 LIFETIME OF THE 3.163 MeV LEVEL OF ^{35}Cl. Barton, R. D.; Wadden, J. S.; Carter, A. L.; Pai, H. L. (Carleton Univ., Ottawa). Can. J. Phys.: 49: 971-8(15 Apr 1971).

The lifetime of the 3.163 MeV level of ^{35}Cl was measured by an improved delayed coincidence technique. The mean lifetime was found to be (37 ± 4) ps. (auth) (Canada)

34024 SPECTROSCOPY OF ^{22}Na WITH THE ^{20}Ne(^{3}He,p) AND ^{20}Ne(^{6}Li,α) REACTIONS. Garrett, J. D. (Univ. of Pennsylvania, Philadelphia); Middleton, R.; Pullen, D. J.; (and others). Nucl. Phys.; A164: 449-83(1971).

The ^{22}Na nucleus has been studied by means of the ^{20}Ne(^{3}He,p) reaction at 15 MeV incident energy and the ^{20}Ne(^{6}Li,α) reaction at 18 MeV bombarding energy. Levels up to 10 MeV of excitation were measured with energy resolutions of 25 keV in the (^{3}He,p) case and of 40 keV in the ^{6}Li induced reaction using the University of Pennsylvania tandem Van de Graaff and multi-angle spectrograph. The systematics of the proton and α-particle angular distribution shapes allow the assignment of values of the transferred angular momentum for a number of transitions, resulting in several new spin–parity assignments. Comparison of the proton and α-particle spectra reveals that T = 1 levels are extremely weakly excited in the (^{6}Li,α) reaction and this fact is used for assigning several T = 1 states. A distorted wave calculation of relative intensities was performed based on a description of the ^{22}Na levels in terms of pure two-particle Nilsson states with associated rotational bands. This analysis is consistent with the ground state K = 3 band and the K = 0, T = 1 band built on the first 0^+ state having simple two-Nilsson-particle character whereas the properties of the second (1.93 MeV) 1^+ state are inconsistent with such a description. It is concluded that the combination of (^{3}He,p) and (^{6}Li,α) reactions employed in the present study provides a powerful spectroscopic tool. (auth)

34025 GAMMA DECAY OF THE 3.90-MeV (2^+) LEVEL IN ^{40}Ca. MacDonald, Jack R. (Bell Telephone Labs., Murray Hill, N. J. Rutgers–The State Univ., New Brunswick, N. J. Brookhaven National Lab., Upton, N. Y.); Wilkinson, D. H.; Alburger, D. E. Phys. Rev., C; 3: 219-28(Jan 1971).

The lifetime and γ-ray branching of the 3.90-MeV (2^+) state of ^{40}Ca have been measured using the reactions ^{40}Ca(p,p′)^{40}Ca at a bombarding energy of 7.32 MeV and ^{39}K(p,γ)^{40}Ca at the E_p = 1.344-MeV resonance. Consistent values for the lifetime were obtained from the Doppler shifts of the 3.90-MeV γ rays in both reactions and from the 0° line shape in the ^{39}K(p,γ)^{40}Ca reaction. A value of τ = 50 ± 5 fsec is adopted for the mean lifetime of the 3.90-MeV state. The 3.90 → 3.35-MeV branching ratio was measured by observing the 0.555-MeV cascade γ rays in quadruple coincidence with the two annihilation γ rays and the inelastic protons in the ^{40}Ca(p,p′)^{40}Ca reaction, or in a triple coincidence with annihilation γ rays in the ^{39}K(p,γ)^{40}Ca reaction. Results are in agreement and the adopted branch is $(7.95 \pm 0.8) \times 10^{-4}$. By combining the lifetime and branching results, the 0.555-MeV E2 transition rate corresponds to a B(E2; 3.90 (2^+) → 3.35 (0^+)) of 250 ± 35 e^2 fm^4. This result is in excellent agreement with recent theoretical estimates of the transition strength. The mean lifetime of the 5.28-MeV (4^+) state of ^{40}Ca was measured to be 310 ± 60 fsec. The corresponding B(E2; 5.28 (4^+) → 3.90 (2^+1)) of 535 ± 110 e^2 fm^4 is in reasonable agreement with expectations based on a strong-deformation rotational model of the states. (auth)

34026 BETA DECAY OF ^{37}S. Kern, B. D. (Univ. of Kentucky, Lexington). Phys. Rev., C; 3: 413(Jan 1971).

New measurements of the energies and the intensity ratio of the two γ rays which are emitted following the β decay of ^{37}S to ^{37}Cl are reported. The more accurate energies are 3102.7(±0.3) keV and 3706(±2) keV, and the revised intensity of the 3706-keV radiation relative to the 3102.7-keV radiation is 0.012(±0.003). The revised log ft value for the β transition to the 3706-keV level of ^{37}Cl is now in better agreement with a recent shell-model calculation. (auth)

34027 STUDY OF ^{88}Sr(p,γ)^{89}Y AND ^{89}Y(p,γ)^{90}Zr FROM E_p = 2.3 TO 3.0 MeV. Umbarger, C. J.; Close, D. A.; Sievers, W. L.; Bearse, R. C. (Univ. of Kansas, Lawrence). Phys. Rev., C; 3: 199-108(Jan 1971).

The ^{88}Sr(p,γ)^{89}Y and ^{89}Y(p,γ)^{90}Zr reactions have been investigated in the energy range E_p = 2.3 to 3.0 MeV. Excitation functions for the transition to the ground state, with a total resolution of 2 keV, were determined for each reaction over this energy region. Using thick targets and both a single Ge(Li) detector and a Ge(Li) detector incorporated into a pair spectrometer, total summed spectra for the 700-keV region were obtained. The average total cross section of ^{88}Sr(p,γ_0)^{89}Y and ^{89}Y(p,γ_0)^{90}Zr was 12 ± 5 μb and 17 ± 7 μb, respectively. These total summed spectra, which represent the total γ-ray yield in this region, have been examined for a possible dependence of the intensity on the J^π of the final state. The data suggest such a J-dependence hypothesis, but detailed theoretical analysis of the ^{88}Sr(p,γ)^{89}Y reaction does not completely agree with experiment. A spectrum from a Ge(Li) detector in coincidence with a NaI(Tl) detector was accumulated for the ^{88}Sr(p,γ)^{89}Y reaction. The decay scheme of the states of ^{89}Y up to an excitation energy of 3.621 MeV was determined and the implications about spins and parities are consistent with accepted assignments. (auth)

34028 RADIATIVE ORBITAL ELECTRON CAPTURE IN ^{57}Co. Lancman, H.; Lebowitz, Jacob M. (Brooklyn Coll.). Phys. Rev., C; 3: 188-91(Jan 1971).

The spectrum of the internal bremsstrahlung accompanying the orbital electron capture in ^{57}Co was investigated in the energy range from 180 to 465 keV. The disintegration energy of ^{57}Co to the second excited state of ^{57}Fe was found to be 674 ± 30 keV. The ratio of the probabilities of the total radiative capture to the nonradiative 1s electron capture was found to be $(0.98 \pm 0.2) \times 10^{-4}$ as compared to the theoretical predicted value of 1.35×10^{-4} for the investigated energy range. A comparison with the results of other intensity measurements of the internal bremsstrahlung is given. (auth)

34029 LIFETIME OF THE FIRST EXCITED STATE IN ^{42}Ti. Bocciolini, M. (Univ., Florence. Istituto Nazionale di Fisica Nucleare, Florence); Sona, P.; Taccetti, N. Lett. Nuovo Cim.; 1: 695-8(24 Apr 1971).

The measurement of the lifetime of the first excited level on ^{42}Ti was performed using the Doppler-shift attenuation method. This level was populated through the (^{3}He,n) reactions at 9 to 10 MeV on natural calcium. This lifetime was found to be $1.7^{+0.9}_{-0.3}$ ps corresponding to B(E2) = 53^{+9}_{-16} fm^4. (J.F.P.)

34030 LOW-LYING LEVELS OF ^{37}Ar. Ragan III, C. E. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Gould, C. R.; Roberson, N. R.; Mitchell, G. E.; Tilley, D. R. Phys. Rev., C; 3: 1152-61(Mar 1971).

The mean lifetimes of the levels of ^{37}Ar below 3.0-MeV excitation energy were measured by applying the Doppler-shift-attenuation method to the ^{34}S(α,n)^{37}Ar reaction (Q_0 = −4.629 MeV). A 450-μg/cm^2 CdS target (enriched to 85.61% in ^{34}S) evaporated onto a 1-μ Ni foil was bombarded with α particles ranging in energy from 7.6 to 8.8 MeV. γ rays were detected at 0, 37, 45, 55, 90, and 143° to the beam axis with a 30-cc Ge(Li) detector. The following mean lifetimes were found: τ(1.41-MeV level) = 1.08 psec, τ(2.22) = 380 ± 50 fsec, τ(2.49) = 775 fsec, and τ(2.80) = 14 ± 11 fsec. Excitation energies for the first five excited states were determined from the ground-state transitions. All five levels were found to undergo γ decay 100% to the ground state; upper limits were set on other possible transitions. Analysis of the γ-ray angular distributions for the levels at 1.61 and 2.49 MeV gave spins in agreement with previous assignments. The angular-distribution and lifetime measurements yield a most probable spin–parity assignment of ($^7/_2^+$) for the 2.22-MeV level. The experimental transition strengths for the positive-parity states are in good agreement with predictions of many-particle shell-model calculations. (auth)

34031 DETERMINATION OF THE ^{85}Sr YIELD RATIO DUE TO THE NUCLEAR REACTIONS Rb(d,2n)^{85m}Sr → ^{85}Sr, AND Rb(d,2n)^{85}Sr IN A THICK TARGET. Hruby, J.; Hradil, M. (Institut fuer Kernforschung, Rez, Czech.). Isotopenpraxis; 6: 397-400(Nov 1970). (In German).

A description is given of the nuclear reaction Rb(d,2n)^{85}Sr used for the production of ^{85}Sr. In a thick target of the RbCl type with deuteron energy of 13 MeV, the ^{85}Sr yield ranges 14.1 μCi/μA. The radionuclide ^{85}Sr originates through the ^{85m}Sr isomer as well as through the Rb(d,2n)^{85}Sr direct reaction. Activity functions referred to 1 μA deuteron flow are provided for ^{85m}Sr and ^{85}Sr in dependance of an exposure time up to 20 hours, and a decay time up to 15 hours. Formation of ^{85}Sr through ^{85m}Sr ranges 65 per-

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cent, while direct origination of ^{85}Sr is 36 percent of total yield. (auth)

34032 HINDRANCE OF M1 TRANSITIONS DESPITE CONFIGURATION MIXING. Zamick, L. (Rutgers–The State Univ., New Brunswick, N. J.). Phys. Lett.; 34B: 472-4(29 Mar 1971).

A condition is given where, despite configuration mixing for particles of one kind in a given j shell, the M1 transitions for all nuclei and all states in question will vanish. It is further shown that in the calcium isotopes and for N = 28 nuclei this condition is nearly met. (auth)

34033 PROTON ELASTIC SCATTERING MEASUREMENTS AT 9.8 MeV WITH OPTICAL-MODEL ANALYSIS. Greenless, G. W.; Poppe, C. H.; Sievers, J. A.; Watson, D. L. (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 3: 1231-42(Mar 1971).

Differential-cross section and polarization measurements are presented for the elastic scattering of 9.8-MeV protons by ^{54}Fe, ^{58}Ni, ^{59}Co, ^{64}Ni, ^{68}Zn, ^{90}Zr, ^{120}Sn, and ^{181}Ta. In general, the angular range 17–160° was covered with an accuracy of ±2% for the cross section and ±0.02 for the polarization measurements. The data are analyzed using an optical model in three ways: (1) using individual data sets for each element and either a seven- or a nine-parameter model; (2) using all the data simultaneously and a "global" search routine; (3) using individual data sets and the folding version of G. W. Greenlees, G. J. Pyle, and Y. C. Tang. The analysis using procedure (1) suggests the model is overparametrized at 9.8 MeV. These difficulties are overcome to some extent using procedures (2) and (3). The most surprising result of the analysis is the insensitivity of the fitting to the choice of spin-orbit parameters at this energy even though relatively accurate and extensive polarization data are available. Thus, in the global analysis, spin-orbit radius parameters anywhere in the range 0.7 to 1.2 F give χ^2 values within 5% of the optimum. The analysis using the folding version of the model indicates that additional effects are present in the interaction which are not included in the description. (auth)

34034 SEARCH FOR AN EXCITED PROLATE ROTATIONAL BAND IN ^{28}Si. Huang, F. C. P.; Gibson, E. F.; McDaniels, D. K. (Univ. of Oregon, Eugene). Phys. Rev., C; 3: 1222-31(Mar 1971).

Lifetime and branching-ratio studies were made in ^{28}Si utilizing the $^{27}Al(p,\gamma)^{28}Si$ reaction. Emphasis was given to measurements on levels at 7380, 7416, 7935, 8328, and 9163 keV as possible candidates for the 2^+ state of an excited prolate rotational band. Combining these lifetime and branching-ratio results to obtain E2 transition strengths for inter- and intraband transitions leads to the conclusion that an excited prolate rotational band is an unlikely possibility. Lifetimes of the 8328- and the 9415-keV states were measured as 150 fsec and 130 fsec, respectively. A remeasurement of the lifetime of the 0^+ level at 4975 keV is in substantial agreement with other recent measurements. (auth)

34035 P-PARITY VIOLATION IN M2 TRANSITION OF ^{41}K. Gaponov, Yu. V.; Fursov, Yu. S. (Inst of Atomic Energy, Moscow). Yadern. Fiz.; 13: 80-3(Jan 1971). (In Russian).

The P-parity violation effect in the strong interaction is considered. The admixture of E2 transitions to the main M2 transition between states $^7/_2^+$ and $^3/_2^-$ with E = 1.29 MeV is calculated. The parameter of admixture is found to be $F = 2.10^{-5}$. It is compared with the experimental value. (auth)

34036 ^{87}Y STATES POPULATED BY SINGLE-PROTON STRIPPING. Maher, J. V.; Comfort, J. R.; Morrison, G. C. (Argonne National Lab., Ill.). Phys. Rev., C; 3: 1162-8(Mar 1971).

The $^{86}Sr(^3He,d)^{87}Y$ reaction was studied at a laboratory beam energy of 20 MeV to test the possible closed-subshell behavior of the 38-proton configuration. The ground-state Q value is found to be 0.346 ± 0.015 MeV. Several new states were identified below an excitation energy of 3.45 MeV. A distorted-wave analysis was used to assign l values for the stripping transitions. Spectroscopic strengths agree well with sum-rule expectations for the 2p, 1f, and $1g_{^9/_2}$ configurations. Comparison with the results of Picard and Bassani for the $^{88}Sr(^3He,d)^{89}Y$ reaction indicates qualitative agreement with shell-model expectations for 2p and 1g strengths but significant deviations for 1f strength and for low-lying 2d strength. (auth)

34037 ENERGY-DEPENDENT BETA-GAMMA CIRCULAR POLARIZATION AND NUCLEAR MATRIX ELEMENTS OF ^{86}Rb. Bosken, J. J.; Ohlms, D. E.; Simms, P. C. (Purdue Univ., Lafayette, Ind.). Contract AT(11-1)-1746. Phys. Rev., C; 3: 1168-72(Mar 1971).

The energy-dependent $\beta-\gamma$ circular polarization was measured in order to set better limits on the matrix-element ratio $\Lambda = \int\vec{\alpha}/(\int i\vec{r}/\rho)$ for the 696-keV first-forbidden β transition of ^{86}Rb. The results show that Λ is consistent with the Fujita–Eichler relation, so the contributions of the off-diagonal matrix elements of the Coulomb Hamiltonian to Λ are small for this transition. The nuclear matrix elements are in agreement with previous results, but the limits of error have been reduced. (auth)

34038 SHELL-MODEL CALCULATIONS FOR ^{60}Cu AND ^{60}Zn WITH REACTION MATRIX ELEMENTS. Singh, R. P.; Rustgi, M. L. (State Univ. of New York, Buffalo). Contract NYO-4022-15. Phys. Rev., C; 3: 1172-9(Mar 1971).

Employing ^{56}Ni as core, and Kuo and Brown renormalized matrix elements for the Hamada–Johnston nucleon–nucleon potential as the residual interaction, the level structure of both ^{60}Cu and ^{60}Zn is studied within the framework of the shell model. The four active nucleons are allowed to populate the $1p_{^3/_2}$, $0f_{^5/_2}$, and $1p_{^1/_2}$ single-particle orbitals. A comparison with the observed level spectra is made, and good agreement with those levels whose spins and parity are definitely known is found. Other levels whose spins and parity assignments are not definite have corresponding theoretical levels which should help in determining their spins in the future measurements. (auth)

34039 ANALYSIS OF PROTON SCATTERING AND REACTIONS WITH THE GENERALIZED OPTICAL MODEL. Spencer, J. E.; Cosman, E. R.; Enge, H. A.; Kerman, A. K. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-)-2098. Phys. Rev., C; 3: 1179-92(Mar 1971).

Isobaric analog resonances in proton scattering experiments are analyzed using a set of coupled optical equations which include both elastic and inelastic channels as well as other channels which can couple to these via the charge-exchange operator ($\vec{\tau}\cdot\mathbf{T}$). The method was applied to the particular case of $^{88}Sr + p$, in which only the $p_0(0^+_1)$ and $p_1(2^+_1)$ proton channels are dominant and mixing of the $(j\times 0^+_1)$ and $(j'\times 2^+_1)$ configurations describes the primary fragmentation of the $2d_{^5/_2}$, $3s_{^1/_2}$, $2d_{^3/_2}$, and $1g_{^7/_2}$ neutron states in the parent nucleus ^{89}Sr. The purpose in this investigation was to see whether or not one could obtain a consistent match to both the level structure of the bound parent analog system and the analog resonance data in the various open channels with a general expression for the effective nucleon-nucleus interaction. Restricting as many parameters and potential terms as possible using independent sources of data, a detailed fit was obtained to the level structure of ^{89}Sr and the resonant $^{88}Sr(p,p_0)$ and (p,p'_1) excitation functions, the resonant $^{88}Sr(p,n)$ total cross-section data, and the elastic polarization functions for an incident proton energy from E_p = 4.8 to 8.2 MeV. The predicted on-resonance $p'(2^+_1)$ angular distributions follow the main features of the data but not the finer details. It was found that the interference between the resonance and the direct inelastic background depends mostly on the nuclear rather than the Coulomb core excitation, and that direct inelastic charge-exchange does not affect the results. The ability to fit all of the data in a consistent manner is interpreted as a confirmation of the main features of the generalized potential model assumed. (auth)

34040 (d, ^{3}He) REACTION ON ^{46}Ti AND ^{48}Ti. Ohnuma, Hajime (Univ. of Minnesota, Minneapolis). Phys. Rev., C; 3: 1192-8(Mar 1971).

The (d,^{3}He) reaction on ^{46}Ti and ^{48}Ti was studied at 19.5 MeV using a magnetic spectrometer. Results were analyzed in terms of distorted-wave Born-approximation theory from which transferred l values and spectroscopic factors were obtained. Transitions with l = 1 to the 0.808-MeV state in ^{47}Sc and to three states in ^{45}Sc were observed, indicating the presence of 2p protons in the ground state of Ti. The single-particle strength appears concentrated in one level in ^{47}Sc, but considerable fragmentation of the strength is seen in ^{45}Sc. It was found that most of the $d_{^3/_2}$ strength is carried by the 0.763-MeV state of ^{47}Sc, and that the spectroscopic factor for the first $^3/_2^+$ level in ^{45}Sc, at 12 keV, is 2.8, or 70% of the sum-rule limit. Three more states with l = 2 were found in ^{45}Sc, one of them known to have $J^\pi = ^5/_2^+$. Assuming that the other two (1.304 and 1.799 MeV) levels have $J^\pi = ^3/_2^+$, the sum of the spectroscopic factors for them is 1.07, or about 25% of the sum-rule limit. (auth)

34041 PROPERTIES OF ELECTROMAGNETIC TRANSITIONS IN ^{20}F AND ^{55}Fe. Hershberger, Robert Lee. Tucson, Ariz.; Univ. of Arizona (1970). 138p. University Microfilms Order No. 71-3669.

Thesis.

A Ge(Li) detector was used in the coincidence version of the Doppler-shift attenuation method to obtain the information concerning the mean lives of the low-lying states in ^{20}F and ^{55}Fe. Slowing down in the target as well as stopping in the backing material is considered. The development of a method which uses a gas as the slowing-down material for the recoiling nucleus

and its use as a check on the mean lives of the first three levels in ^{55}Fe is reported. From the mean life results the reduced matrix elements for electromagnetic transitions among some of the low-lying states in ^{20}F and ^{55}Fe were deduced. A value of $J = 3^+$ is suggested for the spin and parity of the 0.66-MeV state in ^{20}F. Some information is given concerning the branching ratios of the states at 0.82, 0.98, and 1.31 MeV in ^{20}F, and at 2.05 and 2.59 MeV in ^{55}Fe. (Diss. Abstr. Int., B)

34042 STUDY OF ASYMMETRIES IN GAMMA SCATTERING BY ^{57}Fe. Lee, Denny Lap Yen. Houston, Tex.; Univ. of Houston (1970). 126p. University Microfilms Order No. 71-3974. Thesis.

In simple 90° scattering of 14.4 keV gamma-rays from ^{57}Fe, several per cent difference was observed in the intensities of the conjugate lines in the six-line spectrum depending on the vectorial relations between the wave vectors for the incident gamma-rays $\vec{K}_i$, the out going wave vectors, $\vec{K}_f$, and the internal magnetic induction field $\vec{B}$. The intensity of the line corresponding to the $m = \frac{1}{2} \rightarrow \frac{3}{2} \rightarrow \frac{1}{2}$ transition differs from that of the conjugate transition $m = -\frac{1}{2} \rightarrow -\frac{3}{2} \rightarrow -\frac{1}{2}$, by 6.8%. Intensity differences are also found between the $m = \frac{1}{2} \rightarrow -\frac{1}{2} \rightarrow (\frac{1}{2}, -\frac{1}{2})$ line and its conjugate transition line. The sign of this asymmetry depends on the sign of $\vec{K}_i \times \vec{K}_f \cdot \vec{B}$. No asymmetry is expected if the 14.4 keV Mössbauer scattering is considered purely as a two-step process, namely resonance absorption followed by re-emission. It is likely that this asymmetry is the interference between electronic (Thomson) scattering and nuclear resonant scattering as suggested by P. Debrunner. A theory, which agrees closely with this observed asymmetry in sign as well as in magnitude, is established. (Diss. Abstr. Int., B)

34043 STUDY OF ^{25}Al WITH A HIGH-RESOLUTION Ge(Li) GAMMA-RAY SPECTROMETER. Anyas-Weiss, Nicholas. Toronto; Univ. of Toronto (1969). Available from National Library of Canada at Ottawa. Thesis.

In order to test the strong coupling collective model of the nucleus the properties of six levels in ^{25}Al were studied. Angular distribution measurements were carried out and on the basis of the observed multipole mixing ratios and lifetime measurements by the Doppler Shift Attenuation Method (DSAM) transition strengths in ^{25}Al were calculated. These transition strengths were interpreted on the basis of the strong-coupling model of Nilsson. Gamma rays from the ^{24}Mg(p,γ)^{25}Al reaction were studied using several large-volume Ge(Li) detectors. The following resonances in this capture reaction were investigated, E_p = 1200, 1490, 1660* and 1824 keV. The lifetime measurements of the primary gamma rays at the E_p = 1200 and 1824 keV resonances represent examples of resonance width measurements using the DSAM. Lifetime and gamma-ray angular distribution measurements at the E_p = 1200, 1490 and 1824-keV resonances and ^{24}Mg-(p,p'γ) studies carried out at the 1824-keV resonance have led to the spin-parity assignment of $J^\pi(2723) = \frac{7}{2}^+$ as well as rendering the $J^\pi(3422) = \frac{5}{2}^+$ and $J^\pi(4038) = \frac{5}{2}^+$ assignments more plausible than the $\frac{5}{2}^+$ alternatives. Branching ratios for the decays of levels studied were extracted from the angular distribution data, and transition strengths were calculated. A previously unreported resonance at E_p = 2330 keV in the ^{24}Mg(p,p'γ) inelastic scattering reaction was observed. On the basis of the angular distribution of the 1368 keV gamma ray a tentative spin-parity assignment of ($\frac{5}{2}^+$) was made for this resonance. As well as comparing the measured data with theoretical predictions, a comparison with the available data in the mirror nucleus ^{25}Mg was carried out. A triplet of levels at 2.07 MeV in ^{26}Al was established, and the lifetimes and the decay modes of the members of the triplet were measured. Using the ^{27}Al(p,γ)^{28}Si reaction and the DSAM, the lower limit of the lifetime of the level at 9.699 MeV was measured and the total width of the resonance at E_p = 612 keV was obtained. A survey of 16 resonances in the ^{23}Na(α,γ)^{27}Al reaction over the energy range 2 MeV < E_α < 3 MeV was carried out. (Diss. Abstr. Int., B)

34044 LARGE ANGLE ELASTIC SCATTERING OF ^{3}He. Artemov, K. P.; Gol'dberg, V. Z.; Rudakov, V. P.; Serikov, I. N. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 268-76 (Feb 1971). (In Russian).

Large-angle (up to 160°) differential cross sections of 35.7-MeV ^{3}He elastic scattering on ^{24}Mg, ^{27}Al, ^{28}Si, ^{56}Fe, ^{65}Cu, and ^{107}Ag are measured. The results obtained are analyzed on the basis of the optical nuclear model. It is shown that it is impossible to describe the experimental results within the whole angle range at a small depth and any relations between the depth of the real and imaginary parts of the potential, using the Saxon–Woods four-parameter potential. A reasonable agreement between the calculated and measured values of the cross section can be obtained with the potential possessing the deep imaginary part (≈160 MeV) and different formfactors of the real and imaginary parts. It is also noted that even in the wide angle region the differential cross sections weakly depend on the form of potential and on the values of its parameters if the Coulomb parameter $\eta \geq 4$. (auth)

34045 ANALYSIS OF TOTAL RADIATIVE WIDTHS OF NUCLEAR NEUTRON RESONANCES. Maletski, Kh.; Pikel'ner, L. B.; Salamatin, I. M.; Sharapov, E. I. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 240-50(Feb 1971). (In Russian).

Experimental values of total radiative widths, Γ_γ, for nuclei with mass numbers in the interval 60 to 247 (about 100 nuclei) are analyzed. The experimental values are compared with several theoretical expressions. An empirical formula is presented for the radiative widths (depending on the mass number, effective excitation energy of the nucleus, and the level density parameter): $\Gamma_\gamma = 10.5A^{-1}U^1 \cdot a^{-\frac{1}{2}} \cdot (1 - 0.01\ I^2)$. (auth)

34046 γ EMISSION IN THE CAPTURE OF THERMAL NEUTRONS ON Cr ISOTOPES. Broder, D. L.; Gamalii, A. F.; Zemtsev, B. V.; Nesterov, B. V.; Kham'yanov, L. P. Yadern. Fiz.; 13: 233-9(Feb 1971). (In Russian).

Gamma rays emitted in the capture of thermal neutrons on ^{50}Cr, ^{52}Cr, and ^{53}Cr are measured by means of a Ge(Li) γ spectrometer. Yields of γ lines per 100 captures of neutrons in each isotope are determined. Schemes of the energy levels of ^{51}Cr, ^{53}Cr, and ^{54}Cr are given. The results are compared with the data by other authors. (auth)

34047 keV NEUTRON CAPTURE AND TRANSMISSION MEASUREMENTS OF ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, ^{60}Ni, AND V. Stieglitz, R. G.; Hockenbury, R. W.; Block, R. C. (Rensselaer Polytechnic Inst., Troy, N. Y.). Contract AT(30-1)-328. Nucl. Phys.; A163: 592-624(1971).

Neutron capture and transmission measurements were performed on vanadium and enriched samples of ^{60}Ni, ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr with an experimental resolution of 0.6 ns · m^{-1}. The capture measurements cover the energy range 0.1 to 200 keV while the transmission measurements extend to over 300 keV. Parameters are extracted for both s-wave and $l > 0$ resonances. The s-wave and p-wave strength functions, potential scattering radii, average capture cross sections and resonance absorption integrals are determined. The radiation width is found to vary widely among the s-wave resonances of each nuclide, and a positive correlation was observed between the radiation widths and the reduced neutron widths. (auth)

34048 SUBSHELL CONVERSION RATIOS FOR THE M3 ISOMERIC TRANSITIONS IN ^{58m}Co AND IN ^{60m}Co. Pleiter, F. (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys.; A163: 425-31(1971).

An accurate measurement of the relative conversion coefficients of ^{58m}Co and ^{60m}Co is presented. The L1/L23 conversion ratios set an upper limit at $2 \cdot 10^{-4}$ and 10^{-3}, respectively, for the mixing ratio δ^2(E4/M3). A conclusion about the contact density of conduction electrons in cobalt is briefly discussed. (auth)

34049 SPECTROSCOPY OF ^{37}Ar WITH THE ^{35}Cl(τ,pγ)^{37}Ar REACTION. Ivascu, M.; Popescu, D.; van Middelkoop, G. (State Univ., Utrecht). Nucl. Phys.; A163: 418-24(1971).

Excitation energies, branching ratios and mean lives of levels in ^{37}Ar up to 3.61 MeV excitation energy were measured by means of the ^{35}Cl(τ,pγ)^{37}Ar reaction. The γ-rays were measured in coincidence with protons at angles θ_p = +45° and θ_p = −45° for the lifetime measurements, and at θ_p = 180° for measurements of the branching ratios. A new level was found at E_x = 3189 ± 2 keV. From the Doppler-shift attenuation measurements mean lives of τ_m = 650 ± 350, 600 ± 180, 400 ± 130, <25, 30 ± 15, 950 ± 450, 45 ± 30, 220 ± 120 and 50 ± 15 fs were obtained for the ^{37}Ar levels at E_x = 1.41, 2.22, 2.49, 2.80, 3.17, 3.19, 3.27, 3.52 and 3.61 MeV, respectively. From the mean life and the γ-ray decay of the E_x = 3.27 MeV state it follows that $J = \frac{5}{2}$. (auth)

34050 BETA DECAY OF ^{32}P, ^{206}Tl, AND ^{209}Pb. Persson, B. I. (California Inst. of Tech., Pasadena); Plesser, I.; Sunier, J. W. Contracts AT(04-3)-63; AT(11-1)-GEN-10. Nucl. Phys.; A167: No. 3, 470-80(1971).

The shape and the end-point energies of the β-spectra from ^{32}P, ^{206}Tl and ^{209}Pb and the half-lives of the two latter nuclides have been measured with the use of two Si(Li) detectors arranged in 4π geometry. The escape of bremsstrahlung produced in the detectors has been considered in the reduction of the data. Appropriate correction for this effect is essential for the determination of the end-

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point as well as the shape of a spectrum. The following values were obtained for the end-point energies and half-lives: 1707 ± 4 keV for ^{32}P, 1534 ± 5 keV and 251 ± 1 sec for ^{206}Tl, and 634 ± 4 keV and 198.5 ± 2 min for ^{209}Pb. A small deviation from the statistical shape was found in the case of ^{32}P, while the other spectra showed no deviation from the statistical shape. This result disproves a previously reported anomalous non-statistical shape for the ^{206}Tl spectrum, which could not be explained in the framework of the accepted theory of β-decay. (auth)

34051 BETA DECAY OF ^{38}S. Engelbertink, G. A. P.; Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 3: 180-7(Jan 1971).

The β^- decay of ^{38}S to states of ^{38}Cl has been studied with Si, Ge(Li) and NaI(Tl) detectors. ^{38}S was produced in the reaction ^{36}S(t,p)^{38}S at E = 3.26 MeV by bombarding Ag_2S targets, enriched to 1.93% in ^{36}S. The half-life was measured to be 169.6 ± 0.7 min. The main β branch (83 ± 2)% with end-point energy 1005 ± 20 keV proceeds to a previously unidentified level of ^{38}Cl at 1942 keV. A 1941.7 ± 0.2-keV γ ray has been observed in coincidence with this branch. The $\Delta T = 1$ β transition is allowed (log ft = 4.98 ± 0.03) giving $J^\pi = 1^+$ for ^{38}Cl (1942 keV). The γ decay of the 1942-keV level proceeds 100% to the ^{38}Cl ground state, and an upper limit of 0.4% can be set for any other possible decay mode. No γ rays in coincidence with the 1942-keV γ ray were observed. The β- and γ-ray measurements determine the Q value for the ^{38}S(β^-)^{38}Cl reaction as 2947 ± 20 keV. In addition to the main branch a (2.8 ± 0.3)% branch proceeds to the 1746.2 ± 0.4-keV level, which decays predominantly to the ^{38}Cl ground state. The log ft of 6.76 ± 0.05 restricts the 1746-keV level to have $J^\pi = 0^-$, 1^-, or 1^+; the ^{37}Cl(d,p) reaction establishes the parity as odd. No other γ rays from ^{38}Cl were observed, which leads to a value of (14.2 ± 2)% for the ground-state β branch and to a unique first-forbidden matrix element, $\langle G_1 \rangle^2$, of 1.53 ± 0.22 F^2, in excellent agreement with theoretical calculations. The Coulomb energy difference between ^{38}Cl and ^{38}S is determined as 6051 ± 32 keV. The isobaric-multiplet mass equation is used to predict the masses of the lowest $J^\pi = 0^+$, T = 3 states in ^{38}K, ^{38}Ca, ^{38}Sc, and ^{38}Ti. The predicted mass excess for ^{38}Ti is +10.55 ± 0.78 MeV. (auth)

34052 GAMMA-DECAY PROPERTIES OF ^{20}Ne LEVELS BELOW 12 MeV. Haeusser, O. (Atomic Energy of Canada Ltd., Chalk River, Ont.); Alexander, T. K.; McDonald, A. B.; Ewan, G. T.; Litherland, A. E. Nucl. Phys.; A168: No. 1, 17-36 (1971).

Nine levels in ^{20}Ne below 12 MeV excitation were studied using the ^{12}C(^{12}C,$\alpha\gamma$)^{20}Ne reaction. Doppler-shift attenuation measurements on de-excitation γ-rays in three Ge(Li) detectors at 0°, 90° and 125° yielded mean lifetimes (in ps) of levels at 1.633 MeV (1.15 ± 0.20), 4.246 MeV (0.093 ± 0.009), 5.618 MeV (0.20 ± 0.05), 7.004 MeV (0.47 ± 0.09), 9.950 MeV (< 0.035), 10.609 MeV (0.023 ± 0.007), 10.920 MeV (< 0.03) and 11.528 MeV (< 0.03). The mean lifetime of the 4.966 MeV level measured by the recoil-distance method was determined to be 4.8 ± 0.5 ps. New γ-decay branches of (4.8 ± 1.6)% between the 5.618 (3^-) and the 4.966 (2^-) MeV levels, and of (4.5 ± 1.2)% between the 10.609 (6^-) and 8.446 (5^-) MeV levels were observed. These branches firmly establish these levels as members of the negative parity K = 2 band based on the 4.966 MeV level. Particle-gamma angular correlation measurements with six NaI(Tl) detectors yielded the main decay modes of levels at 9.950, 10.920 and 11.528 MeV. The presently known electromagnetic matrix elements are compared with nuclear model predictions. The 5.618 → g.s. E3 transition probability is considerably larger than that predicted by a shell model with four valence particles. (auth)

34053 LIFETIME MEASUREMENTS OF LEVELS OF ^{38}Ar. James, A. N.; Alderson, P. R.; Bailey, D. C.; (and others) (Univ. of Liverpool). Nucl. Phys.; A168: No. 1, 56-64(1971).

Lifetimes have been measured for 11 levels of ^{38}Ar using the Doppler-shift attenuation method with the ^{35}Cl(α,p)^{38}Ar reaction. Limits on the lifetimes of four other levels have also been obtained. Several previously unknown γ-ray decay branching ratios have been measured. The other measured branching ratios agree with earlier data except for the decay of the level at 5513 keV. Assignments of 2^+ for the 5156 keV level and 3^- for the 5513 keV level are confirmed. The agreement of the lifetimes of the negative parity states with previous shell-model calculations is unsatisfactory for $J^\pi = 3^-$ levels. (auth)

34054 4433 AND 6450 keV STATES IN ^{21}Ne. Rolfs, C.; Kuhlmann, E.; Riess, F.; Kraemer, R. (Univ., Freiburg i. B.). Nucl. Phys.; A167: No. 3, 449-64(1971).

The 4433 and 6450 keV states in ^{21}Ne were studied with the ^{18}O(α,nγ)^{21}Ne reaction at E_α = 7.5 to 11.5 MeV. Both neutrons and γ-rays were observed. The investigation involved measurements of nγ and n$\gamma\gamma$ angular correlations for procuring spin and multipole mixing information and of attenuated Doppler shifts for obtaining transition probabilities. The results of this investigation yield: E_x(keV), J^π, τ(fs) = 4433.2 ± 2.0, $11/2^+$, 34 ± 6 and 6450 ± 3, $9/2^+$ or $13/2^+$, <50. These states are good candidates for the $11/2^+$ and $13/2^+$ members, respectively, of the $K^\pi = 3/2^+$ ground state band. The properties of this band are discussed in terms of the rotational and shell models. (auth)

34055 FINE STRUCTURE OF ANALOGUE STATES IN ^{55}Co, ^{57}Co, AND ^{59}Co. Lindstrom, D. P. (Duke Univ., Durham, N. C. Triangle Universities Nuclear Lab., Durham, N. C.); Newson, H. W.; Bilpuch, E. G.; Mitchell, G. E. Nucl. Phys.; A168: No. 1, 37-55(1971).

Differential cross sections were measured at four angles for proton elastic scattering from ^{54,56,58}Fe at energies ranging between 1.8 and 3.3 MeV. Using the TUNL 3 MV Van de Graaff accelerator and high-resolution analyzer-homogenizer system, a total resolution of 300–400 eV was achieved for thin solid targets of enriched iron isotopes. Seven analogue states in ^{55}Co and ^{57}Co appeared as single resonances; three analog states in ^{59}Co showed well-developed fine-structure distributions. Spin, parities and widths were determined for approximately 200 resonances. Spectroscopic factors and Coulomb energy differences were extracted for the analog states. (auth)

34056 BETA DECAY OF ^{35}Ar. Geiger, J. S.; Hooton, B. W. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys.; 49: 663-9(15 Mar 1971). (AECL-3811).

The gamma radiations from the decay of ^{35}Ar were studied using Ge(Li)γ-ray detectors. Evidence is found for previously unreported β feeds to the ^{35}Cl levels at 2695 and 3003 keV. The percentage β feeds to ^{35}Cl levels are the following: 0 keV, 98.3 ± 0.2; 1220 keV, 1.22 ± 0.20; 1763 keV, 0.22 ± 0.05; 2695 keV, 0.16 ± 0.04; and 3003 keV, 0.11 ± 0.03. The ^{35}Ar half-life is found to be 1.787 ± 0.012 s. The present results support the findings of Wick et al. (Nucl. Phys. A, 138(1969)209) that the vector coupling constant determined from the ^{35}Ar ground state beta decay is significantly larger than the values inferred from other super-allowed decays. (auth) (Canada)

34057 LEVELS OF ^{44}Sc BY THE (^{3}He,α) REACTION ON ^{45}Sc. Rapaprot, J. (Ohio Univ., Athens); Belote, T. A.; Bainum, D. E.; Dorenbusch, W. E. Nucl. Phys.; A168: No. 1, 177-89 (1971).

The ^{45}Sc(^{3}He,α)^{44}Sc reaction has been studied at an incident ^{3}He energy of 13.0 MeV. A ground state Q-value of 9.249 ± 0.015 MeV was measured for this reaction. Alpha-particle spectra were obtained at lab angles between 7.5° and 172.5° for transitions to levels below 3.0 MeV excitation energy. A distorted-wave analysis was carried out to obtain l_n values and spectroscopic strengths. The isobaric analog of ^{44}Ca(0) was observed at an excitation energy of 2.763 ± 0.020 MeV. The results are compared with other experimental data and with theoretical predictions. (auth)

34058 VECTOR ANALYSING POWER OF THE (d,p) REACTION ON ^{28}Si, ^{52}Cr, AND ^{88}Sr AT 12 MeV. Debenham, A. A.; Griffith, J. A. R.; Irshad, M.; Karban, O.; Roman, S. (Univ. of Birmingham, Eng.). Nucl. Phys.; A167: 289-304(1971).

The vector analyzing power of the (d,p) reaction leading to several states of the final nuclei ^{29}Si, ^{53}Cr and ^{89}Sr was measured using a 12.3 MeV vector polarized deuteron beam. The data exhibit a distinct j-dependence which is in accordance with known spin and parity assignments of the final states. Present experimental results are compared with existing measurements of proton polarization. An extensive DWBA analysis confirms an applicability of the method for calculating the vector analyzing power for most reactions involving orbital momentum transfer l = 1, 2, 3. It is less satisfactory in cases with l = 0. The effects of optical model parameters and particularly the spin-orbit distortion in the deuteron and proton channel are discussed. (auth)

34059 ^{31}P(^{3}He,p)^{33}S REACTION. Graue, A. (Univ. of Bergen); Lien, J. R.; Rasmussen, L.; Sandvik, G. E.; Cosman, E. R. Contract AT(30-1)-2098. Nucl. Phys.; A162: 593-604(1971).

The ^{31}P(^{3}He,p)^{33}S reaction has been studied at 12.0 MeV incident energy. High-resolution magnetic analysis of the reaction protons enabled 36 levels to be identified up to E_x = 8.3 MeV in ^{33}S. Detailed angular distributions were extracted for most of the transitions. DWBA analyses using the reaction formalisms of Glendenning and Bayman were compared and the predictions of the theoretical wave functions of Glaudemans were tested. Presence of L = 0, 1, 2 and 3 stripping amplitudes was tentatively inferred for several levels and consequent spin assignments suggested. Three analogs of ^{33}P levels were seen, and a brief discussion of Coulomb and symmetry energies is given. (auth)

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34060 FERMI MATRIX ELEMENTS AND CHARGE ASYMMETRY. Yap, C. T.; Tee, C. S. (Univ. of Singapore). Nucl. Phys.: A165: 497-504(1971).

Assuming the validity of the CVC theory the contributions to the Fermi matrix elements M_F for the $\Delta J = 0$, $\Delta T = -1$ β^- decays of ^{24}Na and ^{20}F are calculated. In addition to the usual Coulomb interaction the charge asymmetry of the nuclear force due to η-π and ρ-ω-ϕ mixings, and the electromagnetic radiative corrections are considered. It is shown that contributions from ρ-ω-ϕ mixing and the radiative correlations are generally smaller than those from η-π mixing or the Coulomb interaction. Theoretical values of M_F are deduced and compared with experimental data. For ^{24}Na the theoretical values are generally larger than the experimental values while for ^{20}F good agreement is obtained. (auth)

34061 STUDY OF THE ^{39}K(p,γ)^{40}Ca REACTION FOR PROTON ENERGIES BETWEEN 2.8 MeV AND 3 MeV. Irigaray, Jean-Leon; Bertault, Dominique; Dalmas, Jean; Vidal, Michel; Petit, Georges-Yves (Bordeaux Univ., Gradignan, France). Compt. Rend., Ser. B; 272: No. 8, 481-4(22 Feb 1971). (In French).

The excitation function for the ^{39}K(p,γ)^{40}Ca reaction was determined using thin enriched targets. Three resonances whose strengths were 4.5, 9.5, and 11 eV were found for proton energies of 2,973, 2,980, and 3,004 keV respectively. The decay scheme of the levels for each of these resonances was determined and the existence of energy doublets at 6,931 and 6,936 keV was demonstrated. (auth) (France)

34062 PROPERTIES OF THE 1.410 AND 1.612 MeV LEVELS IN ^{37}Ar AND THE 1.727 MeV LEVEL IN ^{37}Cl. Taras, P.; Turcotte, A.; Vaillancourt, R.; Matas, J. (Univ. of Montreal). Can. J. Phys.: 49: 1215-24(1 May 1971).

The properties of the 1.410 and 1.612 MeV levels in ^{37}Ar and the 1.727 MeV level in ^{37}Cl were investigated. The levels in ^{37}Ar were populated via the ^{37}Cl(p,n)^{37}Ar reaction and the level in ^{37}Cl via the ^{37}Cl(p,p')^{37}Cl reaction. The angular distribution and the linear polarization of the decay gamma rays of these levels were measured at incident proton energies of 3.98, 4.17, 4.38, and 4.81 MeV. The results of these measurements are consistent with a spin of $\frac{1}{2}$ for the 1.410 and 1.727 MeV levels, while they definitely establish the spin and parity of the 1.612 MeV level to be $\frac{7}{2}^-$. This last level was found to decay entirely to the ground state, with a multipolarity mixing ratio $\delta(E3/M2) = +0.22 \pm 0.11$. This level has properties quite similar to those of the $\frac{7}{2}^-$ states in ^{35}Cl and ^{37}Cl, indicating that they may all arise from a $1f_{\frac{7}{2}}$ single-particle excitation. (auth) (Canada)

34063 J-DEPENDENCE IN $l_n = 3$ TRANSITIONS IN THE (d,p) REACTION. Brown, G. (Univ. of Bradford, Eng.); MacGregor, A. E.; Glover, R. N. Nucl. Phys.; A165: 641-61(1971).

The J-dependence of $l_n = 3$ transitions in the (d,p) reaction was studied at $E_d = 8$ MeV, 10 MeV and 12 MeV. Consistent J-dependent effects are shown to be present at forward angles and are used to define a criterion for spin assignments. The J-dependent effects at backward angles are more difficult to define. The J-dependence observed is similar but not identical, to that observed in the (p,d) reaction. It is observed that the role of configuration mixing is not important at forward angles. (auth)

34064 GAMMA DECAY OF AN $f_{\frac{5}{2}}$ ANALOGUE RESONANCE IN ^{51}V. Price, H. G. (Oxford Univ.). Nucl. Phys.; A165: 593-600(1971).

Resonances in ^{50}Ti(p,p'γ) at $E_p = 3.598$ and 3.614 MeV are assigned J^π of $\frac{5}{2}^-$ and $\frac{3}{2}^-$ and interpreted as analogs of ^{51}Ti levels at $E_x = 2.136$ and 2.189 MeV respectively. Spectroscopic factors, and in the case of the $E_p = 3.598$ MeV resonance, which is also observed in ^{50}Ti(p,γ)^{51}V, γ-ray widths and branching ratios were deduced. Resonances in ^{50}Ti(p,p'γ) at $E_p = 2.848$ and 2.983 MeV are assigned J^π of $\frac{1}{2}^-$ and $\frac{5}{2}^-$ and interpreted as the analogs of ^{51}Ti levels at $E_p = 1.43$ and 1.58 MeV respectively. (auth)

34065 CUBIC HARTREE-FOCK SOLUTION IN ^{24}Mg AND PROJECTION CALCULATIONS IN THE 2s-1d SHELL. Glen, J. A.; MacDonald, N. (Univ. of Glasgow). Nucl. Phys.: A165: 524-32(1971).

A solution of the Hartree–Fock problem for ^{24}Mg is found which carries the symmetries of the cubic group. This solution, together with other axial and non-axial Hartree–Fock solutions, is used in an exact projection calculation for ^{24}Mg. The energy spectrum and certain E2 transition rates are calculated. A 0^+ state is given in the region 5 to 8 MeV. Results are also presented for ^{20}Ne, using axial and non-axial solutions. (auth)

34066 PROBABILITY OF REACTION (μ^-,νp) ON ^{28}Si AND ^{39}K NUCLEI. Vil'gel'mova, L.; Evseev, V. S.; Nikityuk, L. N.; Pokrovskii, V. N.; Yutlandov, I. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 551-4(Mar 1971). (In Russian).

The probabilities of reaction (μ^-,νp) on ^{28}Si and ^{39}K measured by the activation method are found to be 0.053 ± 0.010 and 0.032 ± 0.006, respectively. (auth)

34067 ISOBARIC POTENTIAL AND ANALOG STATE DECAY. Birbrair, B. L.; Bukat, G. M.; Fokina, L. P. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: 505-11(Mar 1971). (In Russian).

The expressions for the isobaric potential and matrix elements of the interaction between the isobaric analogs (IAS) and the background states with normal isospin are obtained in the frame of microscopic theory. All results are obtained without using an assumption on the nuclear isospin conservation. The calculations are performed for ^{48}Ca and ^{90}Zr nuclei. (auth)

34068 ACTIVATION CROSS SECTIONS FOR DEUTERON-INDUCED REACTIONS ON CALCIUM ISOTOPES UP TO 5.5 MeV. De Waal, Tielman J.; Peisach, Max; Pretorius, Rene (Southern Universities Nuclear Inst., Faure, S. Afr.). Radiochim. Acta; 15: 123-7(Apr 1971).

Calcium fluoride, of natural isotopic composition and isotopically enriched, was activated with deuteron beams up to 5.5 MeV using a Van de Graaff accelerator. Activation cross sections were determined by gamma-ray spectrometry for the following reactions: ^{40}Ca(d,α)^{38}K; ^{42}Ca(d,n)^{43}Sc; ^{43}Ca(d,n)^{44}Sc; ^{43}Ca(d,n)^{44m}Sc; ^{48}Ca(d,p)^{49}Ca; ^{48}Ca(d,2n)^{48}Sc. The relative accuracy of the excitation functions is $\pm 8\%$ except for the reaction ^{43}Ca(d,n)^{44m}Sc, where the accuracy is $\pm 15\%$. (auth)

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Refer also to abstracts 32640, 32642, 33074, 33076, 33973, 34006, 34019, 34033, 34044, 34045, 34050, 34067, 34155, and 34192.

34069 (AERE-R-6761) THERMAL NEUTRON CAPTURE CROSS SECTIONS OF ^{234}U AND ^{236}U. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell (England)). Mar 1971. 6p. Dep. NTIS (U. S. Sales Only). UK 9p.

Aliquots of mixtures prepared from isotopically pure ^{234}U (98.84%) and isotopically enriched ^{236}U (99.76%) and ^{238}U (99.996%) were irradiated, with cobalt monitors, in the DIDO reactor for approximately two years. The irradiation positions chosen provided essentially thermal neutrons ($r = (7.5) \pm 1.0) \times 10^{-4}$) of known temperature ($116 \pm 9$°C). After irradiation the uranium was purified by reverse-phase partition chromatography, then mass analyzed. Un-irradiated samples of the mixtures were mass analyzed in a similar way. The activities of the cobalt monitors were determined absolutely, and the neutron doses they received could then be calculated. The neutron capture cross sections of ^{234}U and ^{236}U for the reactor neutrons were found to be 101.1 ± 1.3b and 8.86 ± 4.00b, respectively, and from these figures the capture cross sections for Maxwellian neutrons were deduced as 100.5 ± 1.3b and 8.47 ± 4.00b. (auth) (UK)

34070 (COO-1167-13) NUCLEAR CHEMISTRY RESEARCH. Technical Progress Report, December 15, 1969–December 15, 1970. Sugarman, Nathan; Turkevich, Anthony (Chicago Univ., Ill. Enrico Fermi Inst.). 15 Dec 1970. Contract AT(11-1)-1167. 17p. Dep. NTIS.

Research progress in nuclear chemistry at the Enrico Fermi Institute of the University of Chicago in the period Dec. 15, 1969 to Dec. 19, 1970 is briefly reported. The work includes high-energy proton fission and spallation studies, elemental analysis of meteorites and lunar materials, and development of radiation detection equipment. (J.W.R.)

34071 (COO-1167-16) HIGH ENERGY FISSION OF ^{181}Ta AND ^{209}Bi BY 450 MeV PROTONS. Panontin, John A.; Sugarman, Nathan (Chicago Univ., Ill.). [nd]. 108p. (EFINS-71-21). Dep. NTIS.

The thick-target recoil properties of a number of fission products from the 450-MeV proton fission of ^{181}Ta and ^{209}Bi were measured. The average kinetic energy, average cascade deposition energy, and average anisotropy of an isolated product are calculated from the recoil results. An evaporation calculation inciuding fission as a competing mode of de-excitation is per-

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formed, the results of Monte Carlo cascade calculations being employed as input data. The results are used to describe the variation of the average properties of the fissioning nuclei, Z, A, and E*, with the average cascade deposition energy. The characteristics of the most probable fission products, and of the primary fragments leading to them and to the observed products, are then calculated. The average total kinetic energy of the primary fragments is found to be 122 ± 4 MeV and 142 ± 3 MeV, and the average separation of their charge centers at the scission point, 15.3 ± 0.5 and 16.8 ± 0.4 Fermis, for ^{181}Ta and ^{209}Bi, respectively. The results are essentially the same as those found at lower bombarding energies and for comparable nuclides formed in heavy-ion bombardments. The angular distribution of the fission fragments is somewhat anisotropic with the anisotropy factor b/a of products from bismuth exhibiting the same variation with E* as previously reported for uranium—a more pronounced forward–backward emission with increasing deposition energy. The results for tantalum suggest a preferential perpendicular emission of fragments at all deposition energies. The momentum-deposition energy relation obtained from the Monte Carlo intranuclear-cascade calculations leads to an average deposition energy of 214 to 228 MeV and 165 to 172 MeV for the fission process in ^{181}Ta and ^{209}Bi, respectively. The average momentum parallel to the beam direction of cascade nuclei leading to fission is calculated to be 577 to 609 MeV/c and 449 to 467 MeV/c for ^{181}Ta and ^{209}Bi, respectively. The results are compared with those previously reported in a similar study of the fission of ^{238}U. (auth)

34072 (IAE–1985) METHOD OF DIRECT MEASUREMENTS OF THE CAPTURE CROSS SECTION RATIO TO THE FISSION CROSS SECTION. Muradyan, G. V.; Mostovaya, T. A.; Mostovoi, V. I.; Shchepkin, Yu. G. (Institut Atomnoi Energii, Moscow (USSR)). 1970. 24p. (In Russian). Dep. NTIS (U. S. Sales Only).

The direct measurements of the capture cross section ratio to the fission cross section (α) are described. The fission events were recorded by means of ionization chamber. The layer of the studied substance was distributed along the neutron beam and served as the specimen for measuring the capture. Neutron capture was recorded by NaI(Te) crystals. The magnitudes of α for ^{235}U were found in the neutron energy range from 0.3 to 5000 eV. (R.J.V.)

34073 (INDC(CCP)–11/U) CROSS-SECTIONS FOR RADIATIVE NEUTRON CAPTURE BY ^{238}U NUCLEI. Abagyan, L. P.; Abramov, A. I.; Nikolaev, M. N.; Stavissky, Yu. Ya.; Tolstikov, V. A. Translation of Russian report. 29p. Dep. NTIS (U. S. Sales Only).

With a view to establishing reasonable energy resolution and measurement accuracy requirements in respect to cross sections for the radiative capture of neutrons by uranium-238, an analysis was made of the requests contained in RENDA and elsewhere for these cross sections in the energy range 1 eV–15 MeV. The published results of experimental work are considered and their reliability and possible reasons for discrepancies analyzed, particular attention being paid to the choice of reference cross sections and to the calculation of the self-shielding effect. It is noted that the spread of σ_γ (^{238}U) values remaining after all renormalizations far exceeds the accuracy required by the users. Methods of calculating cross sections for capture in uranium-238 are discussed and results are presented. On the basis of selected experiments and calculations an evaluation is made of cross sections for neutron capture by uranium-238, the results being presented in the form of a smooth curve $\sigma_\gamma = \sigma_\gamma(E)$, recommended for use in various calculations. This curve is compared with similar curves obtained by other authors. Methods of obtaining group cross-sections are discussed and new values of group cross-sections for neutron capture in uranium-238 are presented. These are compared with the cross-sections from the 26-group system of constants which used to be employed. (auth)

34074 (JINR–P6-5618) NEW TUNGSTEN ISOTOPES. Nadjakov, E.; Bochev, B.; Venkova, Ts.; (and others) (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions). 1971. 18p. (In Russian). Dep. NTIS (U. S. Sales Only).

In compound-nucleus reactions followed by neutron evaporation, neutron-deficient tungsten isotopes far from the stability region were produced by bombarding ^{155}Gd and ^{156}Gd with ^{22}Ne and ^{20}Ne ions. The isotopes were identified according to the genetic relationships with the daughter isotopes of Hf and Ta. New isotopes of ^{171}W (9.0 ± 1.5 min) and ^{170}W (4 ± 1 min) were found. (auth)

34075 (KFKI–71-8) PHENOMENOLOGICAL FORMULA FOR (n,2n), (p,2n) AND (p,3n) REACTION CROSS-SECTIONS. Jeki, L. (Magyar Tudomanyos Akademia Kozponti Fizikai Kutato Intezete, Budapest). [1970]. 13p. Dep. NTIS (U. S. Sales Only).

A phenomenological formula is suggested for calculating (n,2n), (p,2n), and (p,3n) reaction cross sections; it gives good agreement between the calculated and measured values. (auth)

34076 (KHFTI–70-27) CROSS SECTIONS OF NUCLEAR FISSION BY PHOTONS WITH UP TO 5 GeV ENERGIES. HYPER-GIANT RESONANCES IN PHOTONUCLEAR REACTIONS. Vartapetyan, G. A.; Demekhina, N. A.; Kasilov, V. A.; Ranyuk, Yu. N.; Sorokin, P. V.; Khudaverdyan, A. G. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1970. 17p. (In Russian). Dep. NTIS (U. S. Sales Only).

The glass-detector method was used for measuring the yield of the photofission of ^{238}U, ^{235}U, ^{232}Th, ^{209}Bi, ^{197}Au, and ^{181}Ta in the photon energy range from 100 MeV to 5 GeV. Data obtained were in agreement with the yields calculated on the basis of photomeson fission model. In the photofission cross sections of U and Th, in addition to the giant resonance a resonance takes place at photon energies of ~300 MeV and the width near 1 GeV. Nuclear fission and integral cross sections for photofission are given in graphical form. (tr-auth)

34077 (LA–4652) COMPILATION OF REQUESTS FOR NUCLEAR CROSS SECTION MEASUREMENTS. (Nuclear Cross Sections Advisory Committee (AEC)). Mar 1971. 222p. (NCSAC–35). Dep. NTIS.

This report gives the status of cross-section measurements of importance to the U. S. nuclear energy program and indicates areas where additional experimental work is needed. (R.W.R.)

34078 (LB/G–2943) EMISSION OF DELAYED NEUTRONS: CALCULATION OF ENERGY SPECTRA AND OF PRECURSOR EMISSION PROBABILITIES. Gauvin, H.; de Tourreil, R. Translated by R. G. P. Towndrow (Atomic Energy Research Establishment, Harwell (England)), from pp 621-36 of Physics and Chemistry of Fission, International Atomic Energy Agency, Vienna, 1969. 28p. (CONF-690708–8; SM–122/85). Dep. NTIS (U. S. Sales Only).

The calculations are intended to explain the delayed neutron emission (energy spectra and emission probabilities P_n) that follows the β^- disintegration of the precursors produced by fission. The probability of β^- transition, the level density $\omega(E,J)$ of the emitter, and the competition of (β^-,γ) and (β^-,n) de-excitations are analyzed for each precursor studied. All the possible channels open to the process of neutron emission on grounds of energy considerations (Q_{β^-}, B_n) are taken into account through the introduction of the spin and parity selection rules at each stage of the sequence: precursor, emitter, final nucleus. The results are compared with the known experimental measurements of the neutron energy spectra and probabilities P_n. The precursors ^{87}Br, ^{88}Br, ^{137}I, and $^{93-97}$Rb were selected for this examination. This comparison shows in particular that the structure of experimental energy spectra can be well reproduced by the calculations given. Moreover, the spectra calculated are very sensitive to the choice of the spins of the precursor and the final nucleus. (auth)

34079 (NP–18683) ANNUAL REPORT [ON NUCLEAR PHYSICS], 1969. (Saha Inst. of Nuclear Physics, Calcutta (India)). 216p. Dep. NTIS (U. S. Sales Only).

ACETIC ACID, (ETHYLENEDINITRILO)TETRA—radiolysis of aqueous solutions of, yields from
ANTIMONY-115—energy levels of, calculation using particle-vibration coupling, (T)
ANTIMONY-117—energy levels of, calculation using particle-vibration coupling, (T)
ANTIMONY-119—energy levels of, calculation using particle-vibration coupling, (T)
ANTIMONY-121—energy levels of, calculation using particle-vibration coupling, (T)
ANTIMONY-123—energy levels of, calculation using particle-vibration coupling, (T)
ANTIMONY-125—energy levels of, calculation using particle-vibration coupling, (T)
ARSENIC-75—proton reactions (p,nγ) with, γ spectra from, (E)
ATOMS—reactions with ions, oscillations in cross sections for charge-transfer
BETA PARTICLES—effects on survival of Escherichia coli, internal phosphorus-32
BISMUTH-209—energy levels from polonium-210 (d, He-3) reactions, calculation using particle-core model, (T)
CADMIUM-109—energy-level transitions from indium-109 decay, (E)
CADMIUM IONS—reactions with silver single crystals at 10 to 35 keV

CYCLOTRONS—research at Univ. of Calcutta, 1969
EUROPIUM-151—energy levels from Coulomb excitation, transition probabilities for, (E)
EUROPIUM-153—energy levels from Coulomb excitation, transition probabilities for, (E)
GALENAS—analysis for silver by radiometric method using iodine-131
GAMMA RADIATION—effects on aqueous solutions of potassium iodates
HAFNIUM—determination by radiometric method using phosphorus-37
HOLMIUM-164—decay of ground-state and isomeric, γ spectra from, (E)
INSTRUMENTS—development at Univ. of Calcutta, 1969
IONS—reactions with atoms, oscillations in cross sections for charge-transfer
KRYPTON—mass spectra of
LEAD-209—energy level near 4.00 MeV from (α,p) and (t,d) reactions, single-particle configuration of, (E)
MASS SPECTROGRAPHY—sputtering studies in
MOLYBDENUM-91—beta and electron-capture decay of ground-state and isomeric, γ energies and intensities from, (E)
NEUTRON SOURCES—research at Univ. of Calcutta electrostatic, 1969
NIOBIUM-91—energy-level scheme from molybdenum-81 decay, (E)
NUCLEAR CHEMISTRY—research progress in India on
NUCLEIC ACID, DEOXYRIBO-,—radioinduced strand breaks of, in Escherichia coli, repair mechanisms for uv
OSMIUM-192—energy-level transitions from iridium-192 decay, internal conversion coefficients for, (E)
PLATINUM-192—energy-level transitions from iridium-192 decay, internal conversion coefficients for, (E)
POTASSIUM IODATES—radiolysis of aqueous solutions of, yields from γ
PROMETHIUM-152—beta decay of, γ energies and intensities from, (E)
RADIATION CHEMISTRY—research progress in India on
RUBIDIUM-84—isomeric transition in, multipolarity for, (E)
RUBIDIUM-86—isomeric transition in, multipolarity for, (E)
SAMARIUM-152—energy-level scheme from promethium-152 decay, (E)
SCANDIUM-49—energy levels of, calculation using particle-core model, (T)
SCHIZOMYCOTA—Escherichia coli, radioinduced strand breaks of DNA in, repair mechanisms for uv
—Escherichia coli, effects of 5-bromodeoxyuridine on uv- and x-radiosensitivity of
—Escherichia coli, radiation effects on survival of, internal phosphorus-32 beta and external uv and x
—Escherichia coli, radiation effects on survival of, factors modifying x
SILVER—determination in galena by radiometric methods using iodine-131
—sputtering single crystals of, by cadmium and zinc ions at 10 to 35 keV
SULFATES—transition temperature of manganese-54-containing
ULTRAVIOLET RADIATION—effects on DNA in Escherichia coli, mechanisms for repair of strand breaks induced by
—effects on survival of Escherichia coli
URIDINE, 5-BROMO-2′-DEOXY-,—effects on radiosensitivity of Escherichia coli, uv and x
X RADIATION—effects on survival of Escherichia coli, modifying factors for
—effects on aqueous solutions of EDTA
XENON—mass spectra of
ZINC IONS—reactions with silver single crystals at 10 to 35 keV (D.C.C.)

34080 (NP-18769) MEASUREMENT OF THE RATIO OF THE ^{235}U AND ^{239}Pu CAPTURE AND FISSION CROSS SECTIONS. Belyaev, F. N.; Ignat'ev, K. G.; Sukhoruchkin, S. I.; Borovlev, S. P.; Pavlov, V. V.; Polozov, M. V.; Soldatov, A. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

Because of inconsistencies in alpha values for ^{239}Pu in the neutron energy range of several keV, measurements of this parameter for ^{235}U and ^{239}Pu were performed by means of a neutron spectrometer. Fission and capture effects from metal foil were measured independently by two methods using different kinds of detectors, located on the 14.6-m path flight. Alpha values for ^{235}U and ^{239}Pu were obtained in the energy range of neutrons from thermal to 10 keV. (auth)

34081 (NP-18773) MEASUREMENT OF THE (n,γ) CROSS SECTION FOR ^{99}Tc, Eu, Sm, AND Fe IN THE ENERGY RANGE 1 eV AND 50 keV WITH A SLOWING-DOWN-TIME SPECTROMETER. Chou, Jen-Chang (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Nov 1970. 79p. (In German). (INR-4/70-28) Dep. NTIS (U. S. Sales Only).

The (n,γ) cross sections for ^{99}Tc, Eu, Sm, and Fe were measured with a slowing-down-time spectrometer in energy range from 1 eV to 50 keV. A new normalization method is used, which is based on the absolute calibration of the γ detector as well as the BF_3 neutron detector. The measured capture cross sections were analyzed for considering only the first two partial waves (l = 0 and l = 1). The p-wave strength functions thus obtained are compared with the results from other authors. For the well-resolved resonances, the resonance parameters were determined with the help of the "area method." (auth)

34082 (NYO-2028-5) NUCLEAR REACTIONS IN LIGHT NUCLEI AND MOESSBAUER STUDIES. (Johns Hopkins Univ., Baltimore, Md. Dept. of Physics). Oct 1970. Contract AT(30-1)-2028. 200p. Dep. NTIS.

ALUMINUM-27—energy-level transitions from proton inelastic scattering, multipole mixing ratios for, (E)
BORON-12—nuclear electric and magnetic moments of, (E)
DYSPROSIUM ALLOYS AND SYSTEMS—hyperfine fields in, Moessbauer study of temperature dependence of, (E)
DYSPROSIUM CHLORIDES—paramagnetic relaxation in hexahydrated, Moessbauer study of, (E)
IRON—Moessbauer spectra of thin films of, (E)
IRON-57—energy level at 14.4 keV, NMR study of, (E)
LUTETIUM-175—energy level at 113.8 keV, Moessbauer lifetime measurement for, (E)
MOESSBAUER EFFECT—Debye-Waller factor in, improved approximation to, (E)
NEODYMIUM ALLOYS AND SYSTEM—hyperfine interaction in compounds, Moessbauer study of, (E)
POLARIMETERS—development of Compton, with lithium-drifted germanium detectors, (E)
PROMETHIUM-147—energy level at 91.06 keV, Moessbauer measurement of magnetic moment of, (E)
RARE EARTH ALLOYS AND SYSTEMS—Fe-rare earths, magnetic anisotropy of, Moessbauer study of, (E)
SAMARIUM-147—energy level at 121.2 keV, electric quadrupole and magnetic dipole moments of, (E)
TUNGSTEN-183—energy level at 99 keV, Moessbauer isomer shifts and lifetime measurements for, (E) (J.W.R.)

34083 (NYO-3950-3) NUCLEAR CHEMISTRY. Progress Report, January 1, 1970-December 31, 1970. Brenner, Daeg S. (Clark Univ., Worcester, Mass. Dept. of Chemistry). Contract AT(30-1)-3950. 32p. Dep. NTIS.

Progress in nuclear chemistry research at Clark University during 1970 is reported. The research was principally on nuclear decay schemes. Some previously unreported data on ^{161}Er decay is given. (J.W.R.)

34084 (ORO-2972-170) RESEARCH IN NUCLEAR PHYSICS. Progress Report No. 9. (Texas Univ., Austin. Center for Nuclear Studies). Dec 1970. Contract AT(40-1)-2972. 159p. Dep. NTIS.

Experimental and theoretical research at the Center for Nuclear Studies of the University of Texas in 1970 is reported. Improvements in the experimental facilities are also briefly described. (J.W.R.)

34085 SPIN AND MAGNETIC MOMENT OF ^{109m}Ag. Stinson, G. M.; Pierce, A. R.; Waddington, J. C.; Summers-Gill, R. G. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 49: 906-13 (1 Apr 1971).

Atomic-beam magnetic resonance was used to study the 41-s isomeric state of ^{109}Ag. The measured nuclear spin is 7/2, and the hyperfine interaction constant in the $^3S_{1/2}$ electronic state is found to be 9550 ± 100 MHz. The special nature of the data also provides a direct evaluation of the nuclear magnetic moment, μ_I(corr.) = +4.27 ± 0.13 nuclear magnetons. The accuracy, however, is limited by the possibility of power shifts in the observed resonances; and the error quoted is an estimate of this uncertainty. The moment is in closest agreement with theory if one assumes the state is the result of the coupling of three quasi-particles. (auth) (Canada)

34086 IMPROVED VALUES OF THE E2/M1 MIXING RATIOS OF THE 2_2^+ yields 2_1^+ TRANSITIONS IN ^{126}Te AND ^{126}Xe. Taylor, H. W.; Singh, B. (Univ. of Toronto). Can. J. Phys.; 49: 881-4 (1 Apr 1971).

A new determination of δ for the $2_2^+ \rightarrow 2_1^+$ 754.0-keV gamma

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transition in ^{126}Te and the $2_2^+ \rightarrow 2_1^+$ 491.3-keV transition in ^{126}Xe was carried out with a Ge(Li)–NaI(Tl) directional correlation spectrometer. The values: $\delta(754.0\ \text{keV}) = -4.25^{+0.15}_{0.15}$, $\delta(491.3\ \text{keV}) = +9.1^{+4.3}_{-2.3}$ are a substantial improvement over previous measurements. The difference between the proton and neutron deformations of the first 2^+ state of ^{126}Te is deduced. (auth) (Canada)

34087 INDEPENDENT YIELDS OF MASS-135 XENONS IN THE THERMAL NEUTRON FISSION OF ^{233}U, ^{235}U, ^{239}Pu, AND ^{241}Pu. Hawkings, R. C.; Edwards, W. J.; Olmstead, W. J. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys.; 49: 785-803(1 Apr 1971). (AECL-3812).

The ratio of the independent yield of ^{135}Xe to the cumulative chain yield of ^{135}I in thermal neutron fission of ^{233}U, ^{235}U, ^{239}Pu, and ^{241}Pu was measured using radiochemical techniques. ^{135}Xe and ^{135}Xe^m were recovered quantitatively after short irradiations and compared with ^{135}Xe grown from ^{135}I in the same sample. Corrections were applied for interference from other fission-product gases in the NaI(Tl) γ-ray spectrometry of the rare gas fractions. If the independent yield for ^{135}Xe^m is assumed to be zero, the ratio of the independent yield of ^{135}Xe to the cumulative chain yield to ^{135}I is found to be 0.2790 ± 0.0069 for ^{233}U, 0.0357 ± 0.0019 for ^{235}U, 0.1782 ± 0.0023 for ^{239}Pu, and 0.0332 ± 0.0016 for ^{241}Pu. The ratio of the cumulative chain yield to ^{135}I for thermal fission of ^{239}Pu to that for ^{241}Pu was found to be 0.966 ± 0.054. (auth) (Canada)

34088 DECAY OF ^{205}Hg. Hill, John C. (Texas A and M Univ., College Station); Michalk, V. Phys. Rev., C; 3: 1590-4(Apr 1971).

The decay of ^{205}Hg to levels in ^{205}Tl was investigated using Ge(Li) and NaI(Tl) γ detectors. On the basis of energy, intensity, and coincidence measurements a new decay scheme is proposed. In addition to the first excited state at 203.7 ± 0.2 keV seen in earlier decay studies, levels at 619.3 ± 0.4, 1140.9 ± 0.6, 1218.7 ± 0.4, 1340.3 ± 0.6, and 1433.9 ± 0.5 keV were observed. Spin assignments and log ft values are assigned to all levels. The level scheme is compared with the results of recent reaction studies and with the predictions of a model that considers coupling between single-proton-hole states and vibrations of the core. (auth)

34089 SPIN ISOMERS OF THE SHAPE ISOMER ^{237m}Pu. Russo, P. A.; Vandenbosch, R.; Mehta, M.; Tesmer, J. R.; Wolf, K. L. (Univ. of Washington, Seattle). Phys. Rev., C; 3: 1595-1603(Apr 1971).

Two components in the spontaneous-fission decay of ^{237m}Pu were investigated. The half-lives of the two isomers are 82 ± 8 nsec and 1120 ± 80 nsec. The production ratio of the two components was determined for three different bombarding conditions: ^{235}U + 24-MeV α particles, ^{235}U + 27-MeV α particles, and ^{237}Np + 12.1-MeV deuterons. The dependence of the production ratio on angular-momentum deposition for the various reactions shows that the two shape isomers differ in spin, with the short-lived component corresponding to the lower-spin state. The experimental isomer ratios are compared with statistical-model calculations. If one assumes the validity of the statistical description of isomer population and the absence of a significant γ-decay branch for the high-spin isomer, the deformation associated with shape isomerism can be deduced from isomer-spin information extracted from the present experiment and reference to the Nilsson diagram at large deformation. The deformation indicated is approximately $\epsilon = 0.6$, in good agreement with theoretical estimates. (auth)

34090 RELATIVE QUADRUPOLE MOMENTS OF THE FIRST EXCITED STATES OF ^{182}W, ^{184}W, AND ^{186}W. Oberley, L. W.; Hershkowitz, N.; Wender, S. A.; Carpenter, A. B. (Univ. of Iowa, Iowa City). Phys. Rev., C; 3: 1585-9(Apr 1971).

Moessbauer-effect experiments following Coulomb excitation with a 6.0-MeV beam of ^{4}He ions were performed with tungsten nuclei in tungsten compounds. The first excited states of ^{182}W, ^{184}W, and ^{186}W were investigated simultaneously at both 78°K and between 20 and 30°K. Three different compounds of tungsten were used as absorbers: WO_3, WC, and WS_2. All three yielded consistent results for the relative quadrupole moments for the three tungsten isotopes. These are $Q_{22}^{182} : Q_{22}^{184} : Q_{22}^{186} = 1 : 0.965 \pm 0.008 : 0.906 \pm 0.018$, and they are in reasonable agreement with values of the relative quadrupole moments determined from B(E2) measurements and previous Moessbauer-effect measurements. If the natural linewidth of ^{182}W is 0.997 ± 0.010 mm/sec, then the corresponding natural linewidths of ^{184}W and ^{186}W are 0.95 ± 0.09 and 0.80 ± 0.06 mm/sec. A comparison of the measurements of resonant absorption following Coulomb excitation with those from B(E2) experiments indicates that the rotational model is valid for the lowest-lying energy levels of the even–even tungsten nuclei. (auth)

34091 ANGULAR CORRELATION OF GAMMA CASCADES IN ^{155}Gd AND LEVELS OF ^{155}Gd POPULATED BY THE DECAY OF ^{155}Tb. Bakhru, H. (Yale Univ., New Haven. State Univ. of New York, Albany); Shastry, S.; Boutet, J. Phys. Rev., C; 3: 1603-14(Apr 1971).

The level scheme of ^{155}Gd was studied using high-resolution Ge(Li), Si(Li), and standard scintillation counters. The analysis of the experimental data for this nucleus is impeded by an ambiguity in the spin values of the majority of its excited states. Gamma–gamma angular correlations in the decay of ^{155}Tb were measured using a Ge(Li) detector in coincidence with NaI(Tl) scintillation counter. The spins of some of the levels up to the 648.1-keV level were confirmed from various cascades. The analysis of the various coincidence experiments leads to the proposal of levels in ^{155}Gd at 60.0, 85.5, 105.3, 118.0, 146.0, 235, 266.6, 268.6, 286.8, 326.0, 367.7, 427.4, 451.3, 488.8, 559.9, 592.6, 615.5, and 648.1 keV. A consistent level scheme of ^{155}Gd is proposed, and the spin and parity assignments of the levels are discussed. The multipolarity of the different γ rays including the percentage of mixing is reported. (auth)

34092 STUDY OF THE PARITY VIOLATION IN γ DECAYS OF ^{181}Ta AND ^{175}Lu. Lobashov, V. M.; Nazarenko, V. A.; Saenko, L. F.; (and others) (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz.; 13: 555-75(Mar 1971). (In Russian).

Parity violation in nuclear forces was studied by means of measurements of the circular polarization of the γ quanta emitted by nonpolarized nuclei. The γ transitions of ^{181}Ta (482 keV) and ^{175}Lu (396 keV) were studied. To measure the small circular polarization a method is elaborated that provides the integral monitoring of the γ-ray intensity and the resonance selection of the periodical signal. The method and the measurement operation are described. Phenomena imitating the effect in view are investigated using the ^{46}Sc and ^{82}Br sources with γ quanta that may be assumed to have practically no polarization. The effects due to the bremsstrahlung at the β decay are also studied. The result for the circular polarization of the 482-keV γ transition of ^{181}Ta is $P_\gamma = -(6.1 \pm 0.7) \cdot 10^{-6}$; for the 396-keV transition of ^{175}Lu the polarization is $P_\gamma = +(4.5 \pm 1) \cdot 10^{-5}$. Comparing the experimental results with the estimates obtained in framework of the theory of universal weak interaction one is able to deduce that the observed effects are due to the weak nucleon–nucleon interaction in the nuclei. (auth)

34093 VALUES OF ETA OF ^{233}U, ^{235}U, AND ^{239}Pu FROM CRITICAL EXPERIMENTS AND REACTIVITY MEASUREMENTS. Magnuson, D. W. (Union Carbide Corp., Oak Ridge, Tenn.). Nucl. Sci. Eng.; 44: 266-7(May 1971).

Previously reported values of η, the number of fission neutrons per absorbed neutron, are recomputed for improved data on cross sections and resonance integrals. (R.W.R.)

34094 GAMMA–GAMMA DIRECTIONAL CORRELATIONS IN ^{144}Nd. Arya, Atam P.; Turk, Milica; Arya, Pauline A. (West Virginia Univ., Morgantown). Phys. Rev., C; 3: 1615-18 (Apr 1971).

The γ–γ directional correlations of the 779–617-keV γ cascade and 814–697-keV γ cascade in ^{144}Nd following the decay of ^{144}Pm($t_{\frac{1}{2}}$ = 349 day) were measured using a 10.6-cm^3 Ge(Li) detector and a 3 × 3-in. NaI(Tl) detector in conjunction with a multichannel analyzer in the standard fast-coincidence configuration. The results obtained are consistent with most-probable spin assignments (with second choice in the parentheses) to the various levels as 2^+ for the 1510-keV, 4^+ (6^+) for the 1791-keV, 3 (5) for the 2093-keV, 4^+ for the 2203-keV, and 5^- for the ground state of ^{144}Pm. The possible value of the quadrupole content for the 779-keV γ ray is found to be in the range 11 to 20% or 61 to 80%, while for the 814-keV γ ray, the possible value of the quadrupole content is in the range 36 to 94%. (auth)

34095 APPLICATION OF THE INTERMEDIATE-COUPLING UNIFIED NUCLEAR MODEL TO ODD-MASS CESIUM ISOTOPES. Choudhury, D. C.; Friedman, J. N. (Polytechnic Inst. of Brooklyn). Phys. Rev., C; 3: 1619-30(Apr 1971).

Experimental data on the properties of low-lying levels of the odd-mass cesium isotopes are investigated within the framework of the intermediate-coupling approach in the unified nuclear model. The calculations are performed by assuming that either the last odd proton, having available to it several single-particle states, or the three-proton-hole state in the $1g_{\frac{9}{2}}$ subshell, which can undergo excitations, is coupled to the quadrupole vibrations of the surface of the appropriate doubly even core. For reasonable values of the parameters involved, the calculated low-energy spectra of ^{131}Cs, ^{133}Cs, and ^{135}Cs are in good agreement with experimental data. The wave functions obtained from our model are used to calculate the electromagnetic transition probabilities, lifetimes, and magnetic dipole and electric quadrupole moments for several of the low-lying levels in each of the nuclei considered. These, too, are found to be in substantial agreement with the

available experimental data. The results of our calculations are also compared with other theoretical work. (auth)

34096 ENERGY DEPENDENCE OF THE RECOIL PROPERTIES OF PRODUCTS FROM THE INTERACTION OF ^{238}U WITH 0.45 TO 11.5-GeV PROTONS. Beg, K.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 3: 1631-45(Apr 1971).

The energy dependence of the integral recoil properties and formation cross sections of a number of barium and strontium nuclides produced in the interaction of ^{238}U with protons was studied between 0.45 and 11.5 GeV. The ranges and forward-to-backward ratios (F/B) of the neutron-rich products are nearly independent of energy, and the results indicate that these products are formed in binary fission following interactions with low deposition energies. The ranges of the neutron-deficient products are practically constant up to 1 GeV, decrease by nearly a factor of 2 between 1 and 5 GeV, and decrease very slightly thereafter. The F/B values exhibit a pronounced peak in the vicinity of the midpoint of this interval. The results up to 1 GeV are consistent with binary fission. At this energy a different mechanism becomes noticeable, and by 5 GeV this process predominates. Comparisons are made with the results expected for spallation, fission of a moderately light nucleus, and fragmentation. The latter is the only process which can account for the various experimental results. It is concluded that fragmentation is the main mechanism for the formation of neutron-deficient products lying in the "fission" region for incident energies above 5 GeV. (auth)

34097 E2/M1 MULTIPOLE MIXING RATIOS IN THE SPHERICAL NUCLEI ^{124}Te, ^{126}Te, AND ^{126}Xe. Grabowski, Z. W.; Krane, K. S.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 3: 1649-55(Apr 1971).

E2/M1 mixing ratios of the 709-, 714-, and 723-keV transitions in ^{124}Te, the 754-keV transition in ^{126}Te, and the 491-keV transition in ^{126}Xe were measured using the $\gamma-\gamma$ directional-correlation technique. In addition, the measurements on the 646–603-keV, 1691–603-keV, and 2091–603-keV $\gamma-\gamma$ cascades in ^{124}Te are in agreement with pure E2 character of the 1691- and 2091-keV transitions in ^{124}Te. Coaxial Ge(Li) and Na(Tl) scintillation detectors were used in different combinations depending on the energy resolution required for a particular measurement. The results for the mixing ratios are $\delta(709) = +0.04^{+0.07}_{-0.08}$, $\delta(714) = +0.98 \pm 0.19$, and $\delta(723) = -3.4 \pm 0.1$ for the transitions in ^{124}Te; $\delta(754) = -5.5^{+0.4}_{-0.3}$ for the $2^{+\prime} \rightarrow 2^+$ transition in ^{126}Te; and $\delta(491) = +27^{+\infty}_{-3.0}$ for the $2^{+\prime} \rightarrow 2^+$ transition in ^{126}Xe. There is an indication that the mixing ratios for the $2^{+\prime} \rightarrow 2^+$ transitions in even–even tellurium isotopes are negative and the mixing ratios of similar transitions in even–even Xe isotopes have positive values. (auth)

34098 ANALYSIS OF THE FISSION AND CAPTURE CROSS SECTIONS OF THE CURIUM ISOTOPES. Moore, M. S.; Keyworth, G. A. (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., C 3: 1656-67(Apr 1971).

Using a nuclear explosion as a neutron source, measurements were made of the fission cross sections of ^{244}Cm, ^{245}Cm, ^{246}Cm, ^{247}Cm, and ^{248}Cm between 20 eV and 3 MeV. Radiative-capture cross sections were measured at the same time for a sample of mixed Cm isotopes, consisting primarily of ^{244}Cm and ^{246}Cm. Resonance analysis was carried out for ^{244}Cm between 20 eV and 1 keV, for ^{246}Cm and ^{248}Cm between 20 and 400 eV, and for the odd isotopes between 20 and 60 eV. The results of the analysis show evidence of intermediate structure in the sub-barrier fission of ^{244}Cm. (auth)

34099 STRUCTURE OF ODD-A INDIUM ISOTOPES DETERMINED BY THE (d,^{3}He) REACTION. Weiffenbach, C. V.; Tickle, Robert (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 3: 1668-78(Apr 1971).

The nuclear structure of the odd-A indium isotopes with masses 115, 117, 119, 121, and 123 was studied using the proton-pickup reaction Sn(d,^{3}He)In with a deuteron bombarding energy of 28.9 MeV. Seven or more levels were observed in each isotope. Excitation energies were measured, and l values and spectroscopic factors were extracted from the measured angular distributions. Ground-state Q values were measured relative to that for ^{116}Sn. The five (d,^{3}He) spectra are quite similar. The ground state and levels at approximately 0.3 and 0.6 MeV in each nucleus are excited by pickup of a proton from the $1g_{9/2}$, $2p_{1/2}$, and $2p_{3/2}$ orbitals, respectively. These three levels contain approximately 70% of the $g_{9/2}$ sum-rule strength, 75% of the $p_{1/2}$ strength, and 50% of the $p_{3/2}$ strength. There is evidence for additional $g_{9/2}$ strength in l = 4 transitions near 1.4 MeV in each isotope. The existence of these transitions can be explained by an admixture of the $g_{9/2}$ hole configuration with the $^9/_2^+$ member of the multiplet formed by coupling a $g_{9/2}$ hole to the collective 2^+ state near 1.2 MeV in the tin core. Transitions to levels weakly excited near 1.0 MeV in ^{115}In, ^{117}In, and ^{119}In are best reproduced with l = 2 distorted-wave-approximation curves. If these levels are populated by a one-step l = 2 direct reaction, a nonclosure of the Z = 50 proton shell in the tin ground state is indicated. Surprisingly, no l = 3 transitions corresponding to pickup of protons from the $1f_{5/2}$ orbital were observed, even though most of the isotopes were studied up to 3.5-MeV excitation. (auth)

34100 NEUTRON-CAPTURE GAMMA RAYS FROM THE 14.1-eV RESONANCE IN ^{131}Xe(n,γ)^{132}Xe. Gelletly, W.; Kane, W. R.; MacKenzie, D. R. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., C; 3: 1678-95(Apr 1971).

The γ rays from neutron capture in the 14.1-eV resonance in ^{131}Xe are studied. A target of Na_4XeO_6 was irradiated in a thermal-neutron beam and in monoenergetic neutron beams of 5.16-, 9.47-, and 14.1-eV energy from a neutron diffraction monochromator. The resulting γ-ray singles spectra were studied with Ge(Li) detectors of ≈12-, 15-, 20-, and 30-cm^3 active volume. The γ-rays were assigned to the ^{131}Xe(n,γ)^{132}Xe reaction by a comparison of these spectra. Ge(Li)–Ge(Li) coincidence measurements were carried out on resonance with the 20- and 30-cm^3 Ge(Li) detectors in combination. Fourteen ^{132}Xe γ rays were assigned as primary capture γ rays from the 14.1-eV resonance. The energies (in keV) and relative intensities [I(667.5) = 100] of these primary γ rays are as follows: 8934.2 ± 1.0 (0.02), 8268.5 ± 0.9 (1.0), 6950.1 ± 2.3 (0.14), 6750.1 ± 0.8 (0.13), 6466.8 ± 0.5 (13.2), 6380.5 ± 0.5 (2.8), 6346.8 ± 2.5 (0.09), 6223.0 ± 1.0 (0.23), 5755.0 ± 1.0 (1.9), 5692.3 ± 1.2 (0.4), 4981.1 ± 1.7 (0.3), 4910.3 ± 2.0 (0.7), 4842.3 ± 1.0 (0.7), and 4745.6 ± 2.5 (0.09). These data together with the information obtained from the coincidence measurements and earlier radioactive-decay studies indicate levels in ^{132}Xe with energies 667.5 ± 0.3, 1297.7 ± 0.5, 1440.0 ± 0.3, 1803.9 ± 0.8, 1962.7 ± 0.7, 1985.4 ± 1.0, 2040.2 ± 0.6, 2110.2 ± 0.1, 2168.7 ± 1.3, 2187.2 ± 0.8, 2350.7 ± 0.2, 2394.3 ± 0.5, 2424.9 ± 0.7, 2468.8 ± 0.5, 2555.0 ± 0.6, 2588.66 ± 0.11, 2714.3 ± 1.3, 2754.43 ± 0.13, 3181.3 ± 1.5, 3243.4 ± 1.5, 3954.1 ± 1.0, 4026.5 ± 1.5, 4094.0 ± 1.0, and 4189.5 ± 1.5 keV. The neutron separation energy of ^{132}Xe is 8936.3 ± 1.0 keV. The most prominent feature of the ^{132}Xe level scheme obtained is the strong feeding of the 2468.8-keV level by the intense 6466.8-keV γ ray from the capture state. The observed mode of decay of this level indicates spin and parity 3^- for this state although spin 2 cannot be ruled out. If the 3^- assignment is correct, then the 14.1-eV neutron resonance in ^{131}Xe has spin 2. The properties of the energy levels of ^{132}Xe are discussed. (auth)

34101 PRECISION MEASUREMENT OF THE ^{203}Hg BETA–GAMMA DIRECTIONAL CORRELATION. Cipolla, S. J.; Steffen, R. M. (Purdue Univ., Lafayette, Ind.). Phys. Rev., C; 3: 1720-8(Apr 1971).

A measurement of the $\beta-\gamma$ directional correlation of ^{203}Hg as a function of the average β-energy W (in units mc^2) is reported. The values of the anisotropy coefficient $A_{22}(\overline{W})$ in the $\beta-\gamma$ directional correlation function $W(\theta) = 1 + A_{22}(\overline{W})P_2(\cos\theta)$ are $A_{22}(\overline{W} = 1.15) = -0.007 \pm 0.0009$, $A_{11}(\overline{W} = 1.23) = -0.0016 \pm 0.0006$, $A_{22}(\overline{W} = 1.31) = -0.0020 \pm 0.0010$, $A_{22}(\overline{W} = 1.345) = -0.0018 \pm 0.0005$, and $A_{22}(\overline{W} = 1.38) = 0.0018 \pm 0.0011$. (auth)

34102 NANOSECOND ISOMERIC TRANSITIONS IN ^{155}Gd. Bakhru, H. (State Univ. of New York, Albany). Phys. Rev., C; 3: 1706-9(Apr 1971).

The half-lives of the excited states at 86.5 and 105.3 keV in ^{155}Gd were determined as $T_{1/2}$(86.5 keV) = 6.3 ± 0.1 nsec and $T_{1/2}$(105.3 keV) = 1.18 ± 0.02 nsec. The results are compared with the theoretical calculations of E1 transition rates with the retarding effect of pairing correlations taken into account. The importance of taking into account wave-function components admixed by the Coriolis coupling is discussed. (auth)

34103 BISMUTH L-SUBSHELL FLUORESCENCE AND COSTER–KRONIG YIELDS FROM DECAY OF ^{210}Pb (RaD). Fink, R. W.; Freund, H. U. (Georgia Inst. of Tech., Atlanta). Phys. Rev., C; 3: 1701-2(Apr 1971).

Revised values of L-subshell fluorescence and Coster–Kronig yields at Z = 83 are reported; these values are based on a recalculation of data previously obtained. The revised values are as follows: $\omega_2 = 0.38 \pm 0.02$, $\alpha_2 = 0.45 \pm 0.02$, $\omega_3 = 0.340 \pm 0.018$, $\alpha_3 = 0.660 \pm 0.018$, and $n_{L_2M} = 1.34 \pm 0.14$. The major change is in the value ω_2, which now agrees much better with the trend of values for neighboring elements. The revised value of the ionization multiplicity n_{L_2M} is in good agreement with a recent theoretical value of 1.29. No change results in the previous values for the L_1-subshell quantities. (auth)

34104 HALF-LIFE VARIATIONS OF ^{131}I SAMPLES. Zoller, William H. (Univ. of Maryland, College Park); Hopke, Philip K.;

XUM

Fasching, James L.; Macias, Edward S.; Walters, William B. Phys. Rev., C; 3: 1699-1701(Apr 1971).

The half-life of ^{131}I samples was determined to be 7.969 ± 0.014 day under conditions in which the radiations of 12.0-day ^{131m}Xe are not detected, and to be 8.117 ± 0.012 day under conditions in which the radiations of ^{131m}Xe are detected. Furthermore, no variations of half-life due to the physical state of the source were seen to within 0.3%. These data indicate the half-life variations for ^{131}I reported by Bergamini et al. and Kemeny may be accounted for by the escape of daughter ^{131m}Xe and/or absorption of the radiations of ^{131m}Xe. (auth)

34105 LOW-ENERGY TOTAL NEUTRON CROSS SECTION OF ^{242}Pu. Young, T. E. (Idaho Nuclear Corp., Idaho Falls); Simpson, F. B.; Tate, R. E. Nucl. Sci. Eng.; 43: 341-2(Mar 1971).

The total neutron cross section of ^{242}Pu was measured at 1 meV to 1 eV by using a metallic ^{242}Pu target. These measurements yield 26.9 ± 1 b for the total neutron cross section and 18.5 ± 1 b for the absorption cross section of ^{242}Pu at 0.0253 eV. Reevaluation of available data leads to a weighted value of 19.0 ± 0.6 b for the neutron absorption cross section at 0.0253 eV. (R.W.R.)

34106 COULOMB EXCITATION OF THE 140-keV LEVEL IN ^{193}Ir. Owens, W. R.; Wilenzick, R. M.; Hicks, J. A. (Tulane Univ., New Orleans). Phys. Rev., C; 3: 411(Jan 1971).

A high-resolution Coulomb-excitation study of ^{193}Ir has failed to show any evidence of a 142-keV γ ray attributed to a ground-state transition in two recent papers. (auth)

34107 GAMMA-RAYS FROM THE DECAY OF ^{93m}Mo. Naqvi, S. I. H.; Bubb, I. F.; Wolfson, J. L. (Univ. of Saskatchewan, Regina). Phys. Rev., C; 3: 412(Jan 1971).

The γ rays following the decay of 6.9-h ^{93}Mo have been examined with Ge(Li) and NaI detectors, and improved measurements of energies and intensities have been made. (auth)

34108 FISSION OF ALIGNED ^{235}U NUCLEI INDUCED BY NEUTRONS OF 0.2 TO 2000 eV. Pattenden, N. J. (Atomic Energy Research Establishment, Harwell, Eng.); Postma, H. Nucl. Phys.; A167: 225-46(1971).

The anisotropy of fragments from the neutron-induced fission of aligned ^{235}U has been measured as a function of neutron energy from 0.2 to 2000 eV. The nuclei were aligned in single crystals of rubidium uranyl nitrate, cooled to about 0.1 K. The anisotropy was found to show a rather small variation over the observed resonances and in the unresolved region, indicating that for the open transition states at the barrier K = 0 and 1 and that some states with K = 2 are partially open. (auth)

34109 EXPERIMENTAL INVESTIGATION OF MOTION INDUCED, TEMPERATURE INDEPENDENT, CHANGES IN NEUTRON-NUCLEI INTERACTIONS. Ball, Russell Martin. Charlottsville, Va.; Univ. of Virginia (1970). 164p. University Microfilms Order No. 70-26,615

Thesis.

An investigation of a motion induced, temperature independent, Doppler shift of neutron capture rates has resulted in an analytic and experimental depiction of the magnitude and direction of the shift. Experimental results agree with analytical predictions within experimental error. Epithermal resonance absorptions in gold-197 and thermal resonance absorptions in lutetium-176 were observed to shift in neutron fluxes with highly nonuniform energy distributions. Mechanical motion of sample foils up to 230 meters/second was attained with an air driven, air bearing, high rotational speed rotor. The beam was characterized with flux calibrations and the temperature of the Maxwellian distribution was measured as 90° ± 5°C. The epithermal flux was filtered with a 9.5 mg/cm^2 gold-197 foil and the absorption in a moving sample of gold-197 was observed to shift 4% ± 2% at 200 meters/second maximum velocity. The interaction of a thermal Maxwellian flux with a moving sample of lutetium-176 was observed to shift 14% ± 2% at 200 meters/second maximum velocity. (Diss. Abstr. Int., B)

34110 L AND M SUBSHELL INTERNAL CONVERSION RATIOS FOR ELECTRIC QUADRUPOLE TRANSITIONS. Spenny, David Lorin. Boulder, Colo.; Univ. of Colorado (1970). 187p. University Microfilms Order No. 71-5933.

Thesis.

Recent measurements of L subshell internal conversion ratios for pure E2 transitions have indicated that the L_1/L_2 and L_1/L_3 ratios for nuclei with $64 \lesssim Z \lesssim 76$ are consistently 5 to 6 percent larger than predicted by theory, while for nuclei of higher Z the discrepancy is considerably smaller, possibly changing sign for $Z \gtrsim 88$. Ratios of L_2/L_3 have agreed with theory for most cases. To assist in determining the systematic behavior of L subshell ratio discrepancies, precision measurements of L and M subshell ratios were made for the following pure E2 transitions: the 121.8 keV transition in ^{152}Sm, the 57.5 keV transition in ^{228}Th, and the 84.5 keV transition in ^{224}Ra. The K shell conversion of the ^{152}Sm transition was also measured. The L_1/L_2 and L_1/L_3 ratios for the ^{152}Sm transition are found to be about 6.2 ± 0.7 percent higher than the theoretical values of Hager and Seltzer, while for the ^{228}Th transition they are about 6.7 ± 2.8 percent lower than theory predicts. For the transition in ^{224}Ra these ratios are somewhat higher than theory but with experimental errors that overlap the theoretical values. With the exception of the ^{152}Sm transition the M_1/M_2 and M_1/M_3 ratios follow the same pattern as their respective L ratios but with larger experimental uncertainties. But for ^{152}Sm these M ratios agree with theory while the corresponding L ratios do not. These results would seem to indicate that the L subshell discrepancies are not related to nuclear deformation since the deviations in the two deformed regions are of opposite sign and since a rather large discrepancy is present for ^{152}Sm, a nucleus on the edge of the deformed region. Neither do these results confirm the suggestion that the L subshell discrepancies are related to the minimum which occurs in the L_1 conversion coefficient for low energy F2 transitions in the vicinity of Z = 65. One might expect that near this minimum, where there is a partial cancellation of the lowest order terms, the higher order terms not included in the conversion coefficient calculations might become important. Then the measured ratios involving L_1 might be expected to deviate from the values calculated in lowest order by some small percentage. But such a minimum also exists for the calculated M_1 coefficients, and experimental ratios involving the M_1 subshell in that vicinity show no significant deviation from theory. (Diss. Abstr. Int., B)

34111 SUM-PEAK AND SUM-COINCIDENCE STUDIES IN ^{192}Pt. Suri, K. K.; Mangal, P. C.; Trehan, P. N. (Panjab Univ., Chandigarh, India). Indian J. Pure Appl. Phys.; 8: 394-6(Aug 1970).

The level structure of ^{192}Pt populated in the beta decay of ^{192}Ir was investigated employing scintillation spectrometers in 4π sum-peak coincidence and sum-coincidence modes. The 4π sum-peak coincidence spectra with integral biases set at 200 and 400 keV give some evidence for the existence of 769 keV gamma transition de-exciting the 1380 keV level, but do not favor a 1380 keV cross-over transition from this level. The sum-coincidence spectra with the sum-channel gated at 1380, 1200 and 921 keV support the existence of 769 and 460 keV gamma transitions. (auth)

34112 SPECTRA OF PROTONS FROM (t,pf) REACTIONS ON ^{233}U, ^{238}U, AND ^{237}Np ISOTOPES. Andreev, M. F.; Zavgorodnii, V. A.; Pereshivkin, V. A.; Serov, V. I. At. Energ. (USSR); 30: 57-9(Jan 1971). (In Russian).

The (t,p) reaction with subsequent fission of the compound-nucleus is suitable for determining the fission characteristics of nuclei formed on addition of two neutrons. By means of this reaction it is possible to obtain nuclei at excitation energies substantially less than the binding energy of the neutron in the fissionable nucleus. In this case the neutron emission route is closed so that it becomes easier to study sub-barrier fission. From the form of the proton spectra it is possible to make some conclusions on the fissionability of ^{235}U, ^{240}U, and ^{239}Np. Tritons were accelerated on a tandem electrostatic generator to an energy of 13.23 MeV. These tritons struck an oxide target on an aluminum oxide or gold backing. The target thickness was 300 micrograms/cm^2 for ^{233}U, 400 micrograms/cm^2 for ^{238}U, and 700 micrograms/cm^2 for ^{237}Np. The proton detector was a telescope of silicon semiconductors at a working temperature of −55 to −65°C. Fission fragments were counted in coincidence by a silicon semiconductor detector of the surface-barrier type. From the proton spectra it is evident that fission of ^{240}U and ^{239}Np compound-nuclei takes place at excitation energies less than the binding energy of the neutron in these nuclei. Thus ^{239}U and ^{238}Np can be fissioned by thermal neutrons. (TTT)

34113 MEASURING THE ^{238}U FISSION CROSS SECTION FOR 2.5 MeV NEUTRONS WHILE DETERMINING THE NEUTRON FLUX BY THE METHOD OF ACCOMPANYING PARTICLES. Kuks, I. M.; Matvienko, V. I.; Nemilov, Yu. A.; (and others). At. Energ. (USSR); 30: 55-7(Jan 1971). (In Russian).

A deuteron beam limited by a diaphragm 5 mm in diameter struck a thin deuterium–titanium target on a molybdenum base 0.3 mm thick. A proportional counter 20 mm in diameter filled with argon gas at a pressure of 40 mm Hg std was used to separate the 0.8 MeV ^3He nuclei from the $D(d,n)^3He$ reaction from products of the D(d,p)T mirror reaction. The protons and tritons lost only a small fraction of their energy in the low-pressure pro-

portional counter, while ^{3}He nuclei were stopped completely. Thus an absolute count of ^{3}He nuclei was obtained after suitable corrections. Neutrons from the above reaction were allowed to strike a 10-layer pile of UF_4 deposited on polished aluminum foils 0.1 mm thick. The total weight of uranium (natural mixture of isotopes) was about 10 mg. Mica was used between the UF_4 layers to count the fission events. The ^{238}U fission cross-section for 2.5 MeV neutrons was found to be 0.55 ± 0.02 barns, a value in good agreement with the recently recommended literature value. (TTT)

34114 GAMMA–GAMMA–GAMMA DIRECTIONAL CORRELATION STUDIES FROM THE DECAY OF ^{134}Cs. Pande, U. S.; Singh, B. P. (Univ. of Roorkee, India). Indian J. Pure Appl. Phys.; 8: 401-5(Jul 1970).

Coincidence studies of gamma-gamma-gamma cascades are made in ^{134}Ba from the decay of ^{134}Cs using three scintillation NaI(Ti) detectors kept perpendicular to each other. The cascades thus studied are: (475-563-605 keV), (801-563-605 keV) and (569-796-605 keV). Angular correlation studies are made keeping two detectors detecting first and second gamma of the cascade fixed and moving the detector detecting the third gamma ray of the cascade. The detectors for the first and third radiations are kept in the plane of the table while that for the second gamma (middle) is kept perpendicular to the plane of the table in these studies. Triple correlation functions thus obtained are discussed in the light of spins of excited states and mixture of multipole radiations. Unlike the widely different values obtained by various earlier workers, the mixture values of dipoles and quadrupoles obtained by the present authors for the 475, 563 and 569 keV gamma rays are found to be within the range of the experimental values obtained from the K-conversion coefficient data. (auth)

34115 STUDY OF THE LEVEL STRUCTURE OF N = 82 NUCLEI VIA PROTON-TRANSFER REACTIONS. Wildenthal, B. H. (Michigan State Univ., Fast Lansing. Oak Ridge National Lab., Tenn.); Newman, E.; Auble, R. L. Phys. Rev., C; 3: 1199-1220(Mar 1971).

Measurements of the angular distributions of the (^{3}He,d) and (d,^{3}He) reactions on the stable, even-mass N = 82 isotones are presented and discussed. In each of the residual nuclei formed in these reactions, ^{135}I, ^{137}Cs, ^{139}La, ^{141}Pr, ^{143}Pm, and ^{145}Eu, the lowest two levels are populated with significant strength, one by $l_p = 4$ transfer and one by $l_p = 2$ transfer. Analysis indicates that these states result from coupling a $1g_{7/2}$ or $2d_{5/2}$ proton (or proton hole) to the respective $J^{\pi} = 0^{+}$ target ground states. The relative energies of these states change as a function of mass, the $^{5}/_{2}^{+}$ state lying 590 keV above the $^{7}/_{2}^{+}$ state in ^{135}I, and 330 keV below the $^{7}/_{2}^{+}$ state in ^{145}Eu. Spectroscopic factors extracted from the data with distorted-wave Born-approximation analysis indicate that the active particles in the target ground states predominantly occupy the $1g_{7/2}$ and $2d_{5/2}$ orbits, with the ratio of $1g_{7/2}$ protons to $2d_{5/2}$ protons varying from 3.5/0.5 for ^{136}Xe to 6.3/3.6 for ^{144}Sm. The pickup reactions reveal small admixtures of $1h_{11/2}$, $3s_{1/2}$, and $2d_{3/2}$ protons into the heavier target ground states. These orbits, together with the $1g_{7/2}$ and $2d_{5/2}$, constitute the major shell which fills between Z = 50 and 82. The stripping experiments locate the centroid energies of these higher three orbits relative to the $^{5}/_{2}^{+}$ and $^{7}/_{2}^{+}$ states. It is found that the centroids of the $1h_{11/2}$, $3s_{1/2}$, and $2d_{3/2}$ single-particle states relative to the ground states decrease monotonically from excitations of 1.9, 2.1, and 2.1 MeV, respectively, in ^{137}Cs to excitations of 0.72, 0.81, and 1.1 MeV in ^{145}Eu. (auth)

34116 GAMMA-RAY STUDIES OF THE DECAYS OF ^{142}Xe, ^{142}Cs, ^{142}Ba, AND ^{142}La. Larsen, J. T.; Talbert, W. L. Jr.; McConnell, J. R. (Iowa State Univ., Ames). Phys. Rev.; C; 3: 1372-90(Mar 1971).

Measurements are reported for γ-ray energies and intensities present in the β decays of four nuclei ^{142}Xe, ^{142}Cs, ^{142}Ba, and ^{142}La. These nuclei are all members of the isobaric decay chain beginning with ^{142}Xe, which was made available by use of an on-line isotope separator developed for the study of gaseous fission products. Partial energy level schemes were constructed for ^{142}Cs, ^{142}Ba, ^{142}La, and ^{142}Ce with the aid of Ge(Li)-Ge(Li) coincidence data. Some spin-parity assignments were made and relative transition probabilities determined for levels in ^{142}Ba and ^{142}Ce; comparative half-lives were calculated for the decays of ^{142}Ba and ^{142}La. The energy level scheme of ^{142}Ce suggests vibration-like excitations, but that of ^{142}Ba supports the suggestion of a transition to deformation effects as the neutron number approaches N = 88. (auth)

34117 CORIOLIS COUPLING IN THE ODD TUNGSTEN ISOTOPES. Casten, R. F.; Kleinheinz, P.; Daly, P. J.; Elbek, B. (Univ. of Copenhagen). Phys. Rev., C; 3: 1271-5(Mar 1971).

The (d,p) and (d,t) reactions into the five odd tungsten isotopes from ^{179}W to ^{187}W were studied with 12-MeV incident deuterons. It was found that many gross discrepancies betwen the experimental cross sections and those calculated using the Nilsson model and the distorted-wave Born approximation could be eliminated or reduced by inclusion in the cross-section calculations of the Coriolis interaction with reduced coupling matrix elements. In particular, the highly distinctive systematics of the cross sections in different isotopes could be reproduced. An energy-dependent systematic reduction of the matrix elements which satisfactorily accounts for the experimental observations is suggested. (auth)

34118 ANGULAR DISTRIBUTION OF THE ISOMERIC RATIO OF THE ^{197}Au(p,pn)^{196}Au REACTION WITH 400 MeV PROTONS. Church, L. B. (State Univ. of New York, Buffalo). J. Inorg. Nucl. Chem.; 33: No. 4, 909-14(Apr 1971).

The angular distribution of the isomeric ratio from the ^{197}Au(p,pn)^{196}Au reaction was radiochemically determined. The average ^{196m}Au to ^{196g}Au isomeric ratio is 0.18 ± 0.06 and appears to be constant with respect to the laboratory recoil angle. This is interesting because the reaction mechanism has been postulated to change as a function of this recoil angle. It is therefore concluded that the two predominant mechanisms must give approximately the same isomeric ratio. A calculation of the isomeric ratio which assumes a clean knockout mechanism agrees closely with the experimental value. Another calculation which assumes the inelastic scattering following by evaporation mechanism indicates that the excited (p,p′) nucleus is in a spin state which differs from the target nucleus by about 4.5 ħ units. (auth) (UK)

34119 CHARGED PARTICLE FISSION OF ^{239}U. Choppin, Gregory R.; Kandil, Abdel-Hakim T. (Florida State Univ., Tallahassee). J. Inorg. Nucl. Chem.; 33: 897-902(Apr 1971).

The mass yield curves for fission of ^{239}U by 11.2-MeV protons and 10.6-MeV deuterons were determined using Ge(Li) spectrometry. Gross fission spectra as well as spectra of samples after preliminary radiochemical separation were used. A few spallation yields were also measured. The results are in good agreement with previous data and confirm the value of Ge(Li) spectrometry in fission studies of unseparated samples. (auth) (UK)

34120 ^{148m}Pm HALF LIFE DETERMINATION. Walter, F. W.; Devito, T. A.; Rourke, F. M.; Eiland, H. M. (General Electric Co., Schenectady, N. Y.). J. Inorg. Nucl. Chem.; 33: 1208-12(Apr 1971).

In the course of an investigation of the cross-section of ^{148m}Pm the half-life of this radionuclide was also measured. The measurement was made by mass-spectrometric determination of the ^{147}Pm/^{148m}Pm + ^{148g}Pm atom ratios over a 213-day period of an initially purified ^{147}Pm, ^{148m}Pm, and ^{148g}Pm solution. A computer linear least squares analysis of the data, using an exponential fitting of data points, indicated a value of 41.29 ± 0.11 days (error one standard deviation). This method is not subject to errors which arise with half-life measurement using β or γ decay. (UK)

34121 AN ISOMERIC STATE OF ^{241}Pu. Cabell, M. J.; Wilkins, M. (Atomic Energy Research Establishment, Harwell, Eng.). J. Inorg. Nucl. Chem.; 33: 903-7(Apr 1971).

Mass spectrometric analyses of a freshly irradiated and purified sample of ^{240}Pu did not result in the confirmation of a postulated 0.34 yr isomer of ^{241}Pu. If the isomer decays by direct β emission <1% of the ^{241}Pu could have been present in this form. The half-life of an "old" sample of ^{241}Pu was found to be 15.16 ± 0.19 yr. (auth) (UK)

34122 MEASUREMENT OF THE γ DISINTEGRATION YIELD IN THE DECAY OF ^{147}Pm. McCannon, D. (Battelle-Northwest, Richland, Wash.). Int. J. Appl. Radiat. Isotop.; 22: 253-4(Apr 1971).

In order to quantify the amount of ^{147}Pm in a sample by measurement of the γ-yield, an accurate knowledge of the decay scheme of ^{147}Pm by β emission to an excited level of ^{147}Sm with subsequent emission of a 121.2-keV γ ray is necessary. Published values of the disintegration yield of the γ ray are given. Due to the lack of agreement a study with a lithium-drifted germanium detector relative to the 122.0-keV γ rays from the decay of a ^{57}Co standard reference source was undertaken. Details of the method and equipment used are given. The weighted average of two sets of experiments was found to be $2.93 \pm 0.14 \times 10^{-5}$ γ rays per disintegration. (UK)

34123 NUCLEAR HYPERFINE INTERACTION IN ^{141}Pr. Bent, M. F.; Cook, D. D.; Persson, B. I. (California Inst. of Tech., Pasadena). Contract AT(04-3)-63. Phys. Rev., C; 3: 1419-29(Mar 1971).

Nuclear hyperfine interactions in the 145-keV state of ^{141}Pr were

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investigated by measurements on Moessbauer-scattered γ rays. The magnetic moment of this level was determined to be 2.78 μ_N, a value which is considerably larger than that predicted by Kisslinger and Sorensen. Renormalizing g_l in their calculation to account for meson-exchange effects reduces the disagreement significantly. The magnetic field at the site of the Pr nucleus was investigated for a number of compounds. The values 2.07 ± 0.08 and 0.86 ± 0.06 MOe were obtained for the fields at 4.2°K in PrB_6 and PrO_2, respectively. Although these are only about ½ the values expected for the internal fields in the corresponding free Pr ions, the temperature dependence closely followed a Brillouin function. Line broadening that persisted to temperatures well above the magnetic-ordering temperatures was observed for these compounds indicating the presence of a smaller residual hyperfine interaction. Isomer shifts were observed for a number of Pr compounds. Based on isomer shifts between ionic trivalent and tetravalent compounds, the difference in the mean square charge radii of the excited and ground states is estimated: $\langle r_e^2 \rangle - \langle r_g^2 \rangle = (6.3 \pm 2.5) \times 10^{-3}$ fm^2. (auth)

34124 COLLECTIVE STATES IN THE N = 82 NUCLIDE ^{141}Pr EXCITED BY THE (α,α') REACTION AT 45 MeV. Baer, Helmut W.; Griffin, Henry C.; Gray, W. S. (Univ. of Michigan, Ann Arbor). Phys. Rev., C; 3: 1398-1418(Mar 1971).

The ^{141}Pr(α,α') reaction at E_α = 45.0 MeV and $\Delta E_{\alpha'} \approx 35$ keV was studied to investigate the particle-vibration interaction in this N = 82 nuclide and to elucidate the ^{141}Pr level structure in the 0 to 4-MeV region. The α-particle angular distributions were measured in ≤2° steps over ranges of 7 to 80° for elastic scattering and 12 to 66° for inelastic scattering. A ^{141}Pr(d,d′) spectrum at E_d = 28.7 MeV and with higher resolution (20 keV) was also recorded. These measurements, in combination with other high-resolution studies, establish the existence of approximately 50 levels with excitation energies of 1.1 to 3.0 MeV. Approximately 20 of these levels can be identified in the (α,α') spectra and are interpreted as states with significant collective components. Although most of these levels are in either a positive-parity group between 1.1 and 1.9 MeV or a negative-parity group between 2.0 and 2.5 MeV, it is found that the assumption of a weak particle-vibration interaction based on the 2^+ and 3^- core states of ^{140}Ce and the $d_{\frac{5}{2}}$ ground state of ^{141}Pr is inadequate to explain the results. Qualitative agreement is found with the results of recent shell-model studies which assumed nine active protons outside an inert Z = 50, N = 82 core. In addition, some evidence is found for the approximate validity of the $\Delta B = 0$ selection rule for inelastic scattering transitions which was recently proposed by Hecht and Adler. (auth)

34125 THREE-QUASIPARTICLE STATES IN ^{139}La. DuBard, James L. (Univ. of Louisville, Ky. Florida State Univ., Tallahassee); Sheline, Raymond K.; Ball, James B. Contract AT(40-1)-2434. Phys. Rev., C; 3: 1391-8(Mar 1971).

Absolute differential cross sections of transitions to levels in the N = 82 nucleus ^{139}La populated by the reaction ^{138}La(d,p)^{139}La at 12-MeV bombarding energy were measured with a magnetic spectrograph. The Q value of the reaction is 6553 ± 3 keV. The reaction strongly populates the one-quasiproton ground state of ^{139}La by l = 2 neutron transfer, which establishes positive parity for the ^{138}La ground state. Of the many known states in the region from 1200 to 2000 keV in ^{139}La, only the 1536.3-keV state is weakly populated. The reaction strongly populates a high density of three-quasiparticle states in ^{139}La, beginning at 3355-keV excitation energy, by l = 3 neutron transfer. The shell-model multiplet structure of ^{139}La was calculated using a modified surface δ interaction within a configuration space having $(1g_{\frac{7}{2}})$ and $(2d_{\frac{5}{2}})$ active proton orbitals and $(3s_{\frac{1}{2}})$, $(2d_{\frac{3}{2}})$, $(2f_{\frac{7}{2}})$, and $(3p_{\frac{3}{2}})$ active neutron orbitals. Comparisons between experimental and theoretical multiplet structure are presented. (auth)

34126 INTRINSIC STATES IN ODD-A RHENIUM ISOTOPES. Lu, M. T.; Alford, W. P. (Univ. of Rochester, N. Y.). Phys. Rev., C; 3: 1243-65(Mar 1971).

The intrinsic structure of ^{183}Re, ^{185}Re, and ^{187}Re was studied using the $(^3$He,d) and (α,t) reactions on targets of ^{182}W, ^{184}W, and ^{186}W. Transfer l values were determined from angular distributions in the $(^3$He,d) reaction, and from cross-section ratios in the two different proton stripping reactions. Spectroscopic factors were obtained by comparison with distorted-wave Born-approximation calculations. The low-lying states are found to be well described by the Nilsson model, except that the $\frac{1}{2}^+$[400] and $\frac{11}{2}^-$[505] intrinsic states show mixing with vibrational states. The results also indicate strong mixing of the $\frac{1}{2}^+$[400] and $\frac{3}{2}^+$[402] states with $\frac{1}{2}^+$[660] and $\frac{3}{2}^+$[651] states arising from the N = $6i_{\frac{13}{2}}$ spherical state. (auth)

34127 COLLECTIVE STATES IN ^{178}Hf VIA COULOMB EXCITATION. Varnell, L. (Vanderbilt Univ., Nashville); Hamilton J. H.; Robinson, R. L. Phys. Rev., C; 3: 1265-8(Mar 1971).

Coulomb–excitation experiments were performed to measure transition probabilities of collective quadrupole states in ^{178}Hf. A search for β-vibrational levels yielded negative results. Upper limits are placed on the excitation of the known 2^+ levels at 1276 and 1496 keV. The $B(E2)_{exc}$ values are $\leq 2 \times 10^{-51}$ e^2 cm^4 and $\leq 10^{-50}$ e^2 cm^4 for the 1276- and 1496-keV levels, respectively. Neither of these levels has sufficient excitation strength to be designated as the 2^+ level of the collective β band. The J = 2 level of the $K^\pi = 2^+$ collective γ band is established at 1175 keV, with $B(E2)_{exc} = (10.0 \pm 0.8) \times 10^{-50}$ e^2 cm^4. The angular distribution of the deexcitation γ rays from this level yields $\delta = -32$ with limits $\delta > 32$ or < -11, and >99% E2 multipolarity for the 1081.5-keV $2_\gamma^+ \rightarrow 2_g^+$ transition. The reduced γ-ray branching ratio of the $(2_\gamma \rightarrow 2_g)$-to-$(2_\gamma \rightarrow 0_g)$ transition yields a band-mixing parameter $z_2 = (23 \pm 10) \times 10^{-3}$. (auth)

34128 QUASIROTATIONAL LEVELS IN ^{152}Gd AND EXCITED LEVELS OF ^{152}Tb FROM THE DECAY OF 4.2-min ^{152m}Tb. Bowman, W. W.; Sugihara, T. T.; Hamiter, F. R. (Texas A and M Univ., College Station). Phys. Rev., C; 3: 1275-87(Mar 1971).

In the decay of the 4.2-min isomeric state in ^{152}Tb, 8 γ rays are found to be associated with the deexcitation of levels in ^{152}Tb and 25 γ rays with that in ^{152}Gd. Experimental studies were made chiefly with Ge(Li) γ-ray detectors in singles and coincidence modes. Conversion-electron spectra were obtained with a Si(Li) spectrometer. The isomeric state, believed to be an 8^+ state, is at 501.8 keV, and the isomeric transition is a 159.59-keV E3 transition to a level at 342.2 keV. Other levels in ^{152}Tb are proposed at 58.9, 65.1, and 106.7 keV. An alternative but less likely level scheme is also possible. The ground state (2^-) and levels at 58.9, 342.2, and 501.8 keV appear to be best described in terms of Nilsson states. The electron-capture decay of the 501.8-keV isomeric state is by an allowed unhindered transition (log ft 4.7) which leads almost entirely to a level at 2394.5 keV in ^{152}Gd. The deexcitation of the latter level populates 6^+ and 8^+ members of the quasiground-state and quasi-β-vibrational bands. The quasirotational character of levels in ^{152}Gd which has been proposed by Sakai and coworkers appears to be amply confirmed. A previously unreported level in ^{152}Gd at 1861.7 keV (5^+) is proposed. In contrast to previous work, no α-decay branch was observed. (auth)

34129 BEHAVIOR OF THE CROSS SECTIONS FOR POLONIUM PRODUCTION IN NUCLEAR REACTIONS OF ^{40}Ar WITH ^{164}Dy. Beyec, Y. Le; Lefort, M.; Vigny, A. (Institut Physique Nucleaire, Orsay, France). Phys. Rev., C; 3: 1268-70(Mar 1971).

Excitation functions are reported for the reactions of ^{164}Dy with ^{40}Ar to produce ^{200}Po and ^{199}Po. The cross sections are much smaller than the calculated values and it is concluded that this is due to an angular momentum cutoff and to a large fission width. The reaction threshold at a laboratory energy of 4.2 MeV per nucleon indicates a low Coulomb barrier (r_0 = 1.45 fm). (auth)

34130 GENERALIZED PARAMETERS OF THE S MATRIX FOR ELASTIC SCATTERING. Gonchar, V. Yu.; Zheltonog, K. S. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz.; 13: 84-92(Jan 1971). (In Russian).

A question is considered on the applicability of parametrized phase-shift analysis with five parameters for description of α-particle elastic scattering. By means of an optimization program 33 experimental angular distributions for 21 nuclei from Ne up to Pb at $E_\alpha \sim 40$ MeV are treated on the computer BESM-4. For the ^{58}Ni nucleus the experimental data are treated at eight values of of E_α from 24.7 up to 64 MeV. The dependence of five parameters of the S matrix on the atomic number and on the energy of α particles is studied. The main trends in the behavior of these optimal parameters are expressed as simple semiempiric dependences on the charge and mass and on the energy of α particle. Calculated with the help of these dependences, angular distributions describe with few exceptions the observable effects of cross sections and attenuation of oscillations for the region of atomic numbers from 20 up to 70. The absolute differential cross sections are predicted in this case with a 10% accuracy within the first three diffraction maxima. (auth)

34131 MATRIX ELEMENT ANALYSIS OF THE OUTER AND FIRST INNER GROUP IN ^{140}La. Kemper, K. W. (Florida State Univ., Tallahassee). Nucl. Phys.; A163: 449-52(1971).

Existing quasiparticle wave functions for ^{140}La and ^{140}Ce were used to compute the co-ordinate type β-decay matrix elements for the outer and first inner groups in ^{140}La. The experimental data was analyzed with these matrix elements to obtain values for the relativistic matrix element $\int \alpha$. While the exact values of the matrix elements are extremely sensitive to the amplitudes of the components in the wave functions, a comparison of the results

for the two groups shows the matrix elements for the 3^- $(\beta)2^+$ transition to be 5–10 times smaller than those for the 3^- $(\beta)4^+$ transition. Also, the correction term to the Fujita result for $\Lambda = \int \alpha / \int r$ proposed by Damgaard and Winther was calculated, but this term still does not explain the discrepancy between the theoretical value for Λ and that obtained experimentally. (auth)

34132 STUDIES OF ^{152}Nd AND ^{162}Gd BY DOUBLE NEUTRON CAPTURE AND DECAY SCHEME OF ^{162}Gd. Chang, Jian Cherng. Columbia, Mo.; Univ. of Missouri (1970). 91p. University Microfilms Order No. 71-3319.

Thesis.

Short-lived ^{162}Gd was produced by double neutron capture and investigated with Ge(Li) and Si(Li) detectors. Gamma rays with energies of 402.8 and 441.6 keV were found to decay with a half-life of 8.2 ± 0.3 min. Coincidence measurements revealed a gamma ray with 38.8 keV and led to a proposed decay scheme with levels in odd ^{162}Tb characterized by (K, I^π) at the following energies in keV: 0(1,1⁻), 38.8(1,2⁻), and 441.6(1,1⁺). The two lowest levels are interpreted as the intrinsic configuration $\frac{3}{2}^+$ $(411)_p - \frac{5}{2}^-$ $(523)_n$ and the highest as $\frac{7}{2}^-$ $(523)_p - \frac{5}{2}^-$ $(523)_n$. A neutron activation cross section of $(1.9 \pm 0.6) \times 10^4$ barns was obtained for ^{161}Gd. Attempts were also made to produce even ^{152}Nd by double neutron capture. Discussions of nuclear models are presented which emphasize the theoretical bases for the quantum numbers used in describing deformed odd nuclei. (Diss. Abstr. Int., B)

34133 DECAY OF ^{109}Pd, /sup 111g/Pd, AND /sup 111m/Pd. Barnes, Walter Earl. Corvallis, Oreg.; Oregon State Univ. (1971). 140p. University Microfilms Order No. 71-2461.

Thesis.

The decay of ^{109}Pd, ^{111g}Pd, and ^{111m}Pd produced by thermal neutron irradiation of palladium targets was investigated. Gamma ray energies and relative intensities were measured with a high resolution Ge(Li) spectrometer. From energy sums and relative intensity considerations level schemes for ^{109}Ag and ^{111}Ag are constructed. On the basis of beta and gamma selection rules, spin-parity assignments are made for the levels of ^{109}Ag and ^{111}Ag. The results of this study are compared with recent theoretical calculations. (Diss. Abstr. Int., B)

34134 VARIATIONS OF RATIOS OF THE FRAGMENT YIELDS PRECEDING THE RETARDED NEUTRONS IN FISSION OF ^{239}Pu AND ^{233}U BY NEUTRONS WITH ENERGIES 18 TO 21 MeV. Maksyutenko, B. P.; Ramazanov, R.; Tarasko, M. Z. Yadern. Fiz.; 13: 293-9(Feb 1971). (In Russian).

Relative yields of delayed neutrons in the fission of ^{239}Pu and ^{233}U by neutrons with energies from 18 to 21 MeV are determined. The work was carried out with a Van de Graaff accelerator using the T (d,n) ^{4}He reaction with a target of thickness ~1.6 mg/cm^2. As compared with previous measurements on thick target (~20 mg/cm^2), the structure of the relative yields is now more apparent, as has been expected. Possible reasons of this effect are discussed in view of variation of the charge distribution at fission with change of the energy of neutrons inducing the fission. (auth)

34135 STUDY OF α DECAY OF 105 ELEMENT ISOTOPES. Druin, V. A.; Demin, A. G.; Kharitonov, Yu. P.; (and others) (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 251-5(Feb 1971). (In Russian).

Experimental results are given on the study of α decay of the 105 element isotopes produced from bombarding ^{243}Am by ^{22}Ne ions. The activity with the energy of α particle of 9.1 and 8.9 MeV is selected using the amplitude-time correlation method. The decay half-time of this activity is 1.4 sec, in agreement with the data of Flerov et al. on the spontaneous fission of the element 105. (auth)

34136 MEASUREMENTS OF SOME NUCLEAR LIFETIMES IN THE NANOSECOND REGION. Bond, P. D.; McGervey, J. D.; Jha, S. (Case Western Reserve Univ., Cleveland). Nucl. Phys.; A163: 571-6(1971).

New delayed-coincidence measurements are reported for the mean lifetimes of some nuclear levels, namely (in order of increasing lifetime), ^{101}Ru(127 keV), ^{188}Os(155 keV), ^{95}Mo(204 keV), ^{125}Te(35.5 keV), ^{140}Ce(2083 keV), ^{99}Tc(181 keV), ^{191}Ir(82 keV), ^{133}Cs(80 keV), ^{48}V(310 keV), and ^{181}Ta(482 keV). The respective lifetimes are, in ns, 0.93 ± 0.02, 1.03 ± 0.03, 1.09 ± 0.02, 2.03 ± 0.05, 4.98 ± 0.13, 5.20 ± 0.13, 5.80 ± 0.17, 9.06 ± 0.20, 10.4 ± 0.30, and 15.9 ± 0.5, respectively. (auth)

34137 POLARIZED ELECTRONS BY MOTT SCATTERING AT BULK TARGETS. Boersch, H.; Schliepe, R.; Schriefl, K. E. (Technische Univ., Berlin). Nucl. Phys.; A163: 625-36(1971).

Mott 120° double scattering experiments with bulk gold targets and energy filtering of the scattered electrons were performed in the energy range 22–48 keV. The polarization degrees are the largest experimental values hitherto published for Mott scattering in this energy range but they are smaller than the theoretical Sherman function computed very accurately some time ago. However, deviations of experimental values from theoretical ones do not exceed 20%. The filter method introduced here is based on the assumption that the mean path of plurally scattered electrons in the target is considerably larger than of singly scattered electrons. Hence, the probability of additional inelastic scattering events is larger in the case of plural than in the case of single scattering. That is why nearly all elastically large-angle scattered electrons are singly scattered electrons with a large polarization degree. The influence of the small angle multiple scattering may be neglected for the present. Mott scattering by bulk targets and the selection of the elastically scattered electrons by energy filtering give a simple source of nearly monoenergetic electron beams of high intensity with a well-reproducible and large polarization degree (0.27 at 32 keV). (auth)

34138 CROSS SECTIONS FOR BINARY AND TERNARY FISSION INDUCED BY HIGH-ENERGY PROTONS IN URANIUM AND LEAD. Remy, G.; Ralarosy, J.; Stein, R.; Debeauvais, M.; Tripier, J. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys.; A163: 583-91(1971).

Binary and ternary fission cross sections were studied for uranium and lead targets. The energies of the incoming proton were 0.6, 2, 3, 18 and 23 GeV. The detector used was a solid state plastic detector (makrofol). (auth)

34139 STRUCTURE AND ELECTROMAGNETIC PROPERTIES OF THE ODD-A ANTIMONY ISOTOPES IN A UNIFIED-MODEL CALCULATION. Vanden Berghe, G.; Heyde, K. (State Univ., Ghent). Nucl. Phys.; A163: 478-512(1971).

The level schemes of the odd-proton Sb isotopes with $115 \leq A \leq 125$ are calculated in a unified-model approach up to second order in the collective variables. The addition of octupole vibrations is necessary to explain the structure of the $\frac{11}{2}^-$ states and certain γ-transitions. The l-forbidden M1 transitions give stable results for B(M1) through the velocity-dependent correction to the magnetic multipole operators. Also spectroscopic factors to levels in the Sb isotopes as obtained in the (^{3}He, d) stripping reactions are calculated and compared in their A-dependence and in the distribution in each nucleus with experimental data. Electromagnetic (Mλ and Eλ) moments and transition rates are derived. Effective g_S and g_R factors are determined in a fitting procedure to known magnetic moments. (auth)

34140 BLOCKING OBSERVED IN (p,t) REACTIONS ON THE ODD TIN ISOTOPES. Fleming, Donald G. (Univ. of Copenhagen); Blann, Marshall; Fulbright, H. W. Nucl. Phys.; A163: 401-17 (1971).

The odd tin nuclei were investigated by 20 MeV (p,t) reactions on the isotopes ^{119}Sn, ^{117}Sn and ^{115}Sn. The observed cross sections are compared with the BCS predictions of both Arvieu and Clement and Baranger, assuming a first-order model of pure one-quasiparticle and pure three-quasiparticle final states. The one-quasiparticle states are relatively strongly populated. Due to the Pauli exclusion principle, the core strength leading to three-quasiparticle final states can be drastically reduced compared to its value in the even tin isotopes. The ground-state to ground-state cross sections are similarly affected. The (p,t) reaction can be a very sensitive probe of expected particle-vibration coupling structure. The cross-section comparisons presented suggest that the contributions of higher-lying orbits to the BCS ground state in the Clement and Baranger calculations are somewhat too strong in the region of $\frac{1}{2}^+$ ground states. (auth)

34141 PROGRAM FOR FITTING TRANSITION ENERGIES INTO A LEVEL SCHEME ACCORDING TO THE COMBINATION PRINCIPLE. Williams, I. R. (Knoxville Coll., Tenn.). Comput. Phys. Commun.; 1: 465-7(Dec 1970).

The essential input data are the measured photon energies and any level energies that are known. The program starts at a specified energy (E) and ascertains whether an energy level, an energy level + a quantum, an energy level – a quantum, or a quantum + another quantum has that energy E within experimental error. The value of E is reduced slightly; and the program loops through the series of questions, writing pertinent data if an affirmative answer is obtained. Written in FORTRAN IV, the program requires storage of 1100 32-bit words on the IBM 360/91 and 2500 24-bit words on the SEL 840A. This program takes no consideration of the fact that a transition between two levels may be forbidden because of an angular momentum and parity barrier. In addition, no intensity

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balance is accounted for in the program so that it is necessary to be on guard against accepting the assignment of a transition to a state in the decay scheme when this is totally unreasonable from intensity considerations. (R.W.R.)

34142 DECAY OF ^{197}Pt. Prieels, R.; Deutsch, J. P. (Univ. Catholique, Louvain, Belgium). Nucl. Phys.; A167: No. 3, 667-72(1971).

In the decay of ^{197}Pt, the β-branches leading to the 279 keV level and the ground state of ^{197}Au were investigated. The corresponding branching ratios were found to be smaller than $2 \cdot 10^{-5}$ and $(9.82 \pm 0.34) \cdot 10^{-2}$, respectively. The $\beta\gamma$ directional correlation of the cascade through the 268 keV level of ^{197}Au was found to be isotropic. The implications of these results are discussed and a refined decay scheme is constructed for ^{197}Pt. (auth)

34143 RECIPES FOR MULTIPLE SCATTERING CORRECTIONS. Engelbrecht, C. A. (Atomic Energy Board, Pelindaba, South Africa). Nucl. Instrum. Methods; 93: No. 1, 103-7(1971).

The summation of scattering events to all orders yields surprisingly simple expressions for the corrections required for the extraction of integrated cross sections and angular distributions from experimental results obtained with thick scattering samples. The inclusion of recoil corrections is also discussed. These results may be applied, for example, to the elastic and inelastic scattering of neutrons as well as subsequent decay gamma-rays obtained from solid or hollow cylindrical samples of arbitrary dimensions. (auth)

34144 NUMERICAL ANALYSIS OF THE OPTIMUM ANGLE AND MEASURING TIME FOR ANGULAR CORRELATION MEASUREMENTS. Waibel, E.; Grosswendt, B. (Physikalisch-Technische Bundesanstalt, Brunswick). Nucl. Instrum. Methods; 93: No. 1, 61-7(1971). (In German).

Expressing the angular-correlation function $W(\vartheta)$ in terms of Legendre polynomials $P_k(\cos\vartheta)$ the best set of angles and corresponding weights of observations was determined by minimizing the variance for the case of $W(\vartheta) = A_0 + A_2P_2(\cos\vartheta) + A_4P_4(\cos\vartheta)$. Deviations from the best parameters influencing the variances of the different expansion coefficients and the total variance are studied. It is shown that the response of the total variance remains rather flat. (auth)

34145 LEVEL STRUCTURE OF ^{197}Au. Barnard, E.; De-Villiers, J. A. M.; Engelbrecht, C. A.; Reitmann, D. (Atomic Energy Board, Pelindaba, South Africa). Nucl. Phys.; A167: No. 3, 511-28(1971).

A 3 MV Van de Graaff accelerator was used together with a 40 cm^3 Ge(Li) detector in a time-of-flight arrangement to study the de-excitation γ-rays following the inelastic scattering of neutrons from ^{197}Au. Using incident neutron energies up to 1.3 MeV, accurate γ-ray energies and intensities as well as their threshold behavior were determined. From these data together with structure considerations a consistent level and decay scheme for ^{197}Au was constructed. The level energies, decay γ-rays with branching ratios, and spins and parities are given for 18 excited states. (auth)

34146 ^{210}Pb(p,d)^{209}Pb REACTION AT 20.6 MeV. Igo, G. (Los Alamos Scientific Lab., N. Mex. Univ. of California, Los Angeles); Flynn, E. R.; Dropesky, B. J.; Barnes, P. D. Phys. Rev., C; 3: 349-63(Jan 1971).

The ^{210}Pb(p,d)^{209}Pb reaction has been studied at an energy of 20.6 MeV in the angular range 13 to 70°. The objectives of the work were twofold. First, the fragmentation of the two-particle–one-hole $\nu_0 + {}^2\nu_{nlj}{}^{-1}$ strength up to an excitation in ^{209}Pb of 5.3 MeV was investigated and compared with the corresponding $\nu_{nlj}{}^{-1}$ strength in ^{207}Pb as reported in a recent study of the ^{208}Pb(p,d) reaction at 20 and 22 MeV. Second, the microscopic structure of the valence neutrons ν^2_{0+} in the ground state of ^{210}Pb was investigated by measuring the spectroscopic factors for pickup to the six low-lying neutron single-particle states in ^{209}Pb. (auth)

34147 MASS YIELDS FROM THE SPONTANEOUS FISSION OF ^{252}Cf. Harbour, R. M.; Eichor, Matt; Troutner, D. E. (Oak Ridge National Lab., Tenn. Univ. of Missouri, Columbia). Radiochim. Acta; 15: 146-50(Apr 1971).

Several mass yields for the spontaneous fission of ^{252}Cf have been measured using both radiochemical techniques and high-resolution gamma-ray spectroscopy. The mass yields of ^{102}Mo, ^{103}Ru, ^{106}Ru and ^{144}Ce are 3.7 ± 0.1, 4.8 ± 0.4, 5.8 ± 0.3, and 5.7 ± 0.2 percent, respectively. A point-to-point comparison of the yield of each chain in the mass region A = 131-137 is made. The results indicate a smooth increase in mass yields in this region with little evidence for fine structure in the mass-yield curve. (auth)

34148 STUDY ON THE REACTOR NEUTRON INDUCED FISSION OF ^{232}U. Kemmer, J.; Kim, J. I.; Born, H.-J. (Technische Univ., Munich). Radiochim. Acta; 15: 113-17(Apr 1971).

By applying a recoil technique and direct gamma spectrometry, 16 chain yields have been determined in the reactor neutron induced fission of ^{232}U. The peak positions of both light and heavy mass are found at the mass number 93.0 and 137.3, respectively. The peak widths at half height and $1/_{10}$ of the height are 13.3 and 21.3 amu, respectively. The average number of neutron emission per fission is found to be 2.6. (auth)

34149 DECAY OF ^{99}Nb($T_{1/2}$ = 2.6 min.). Cavalini, P.; Blachot, J.; Monnand, E.; Moussa, A. (CEN, Grenoble, France). Radiochim. Acta; 15: 105-8(Apr 1971). (In French).

The 2.6-min ^{99}Nb isomer produced in the thermal neutron fission of ^{235}U was studied. The separation of ^{99}Nb from the other fission products is made by fractional sublimation in a tube processing a temperature gradient, or by solvent extraction. 53 γ-rays are observed with Ge(Li) detectors. A level scheme for ^{99}Mo is proposed, built-up from $\beta-\gamma$ and $\gamma-\gamma$ coincidence and from previous studies by nuclear reactions made on this nucleus. (auth)

34150 DELAYED NEUTRON YIELDS FROM 14.8 MeV NEUTRON INDUCED FISSION OF ^{238}U, ^{232}Th, AND ^{231}Pa. Brown, M. G.; Lyle, S. J.; Martin, E. B. M. (Univ. of Kent, Eng.). Radiochim. Acta; 15: 109-13(Apr 1971).

Delayed neutron yields within the 55, 22, 6, and 2 sec groups have been measured absolutely for 14.8 MeV neutron induced fission of ^{238}U, ^{232}Th, and ^{231}Pa. The results for ^{238}U and ^{232}Th are in better agreement with those reported by Herrmann et al. ["Delayed Fission Neutrons," I. A. E. A. Panel Proceedings, Vienna 1967] than with values published before 1965. The yields for the 22, 6 and 2 sec periods from fission of ^{231}Pa are lower by factors of 3 to 5 than corresponding yields from ^{238}U or ^{232}Th. (auth)

34151 ^{103} ^{105}Ru STATES OBSERVED IN THE REACTIONS ^{102} ^{104}Ru(d,p). Fortune, H. T. (Argonne National Lab., Ill.); Morrison, G. C.; Nolen, J. A. Jr.; Kienle, P. Phys. Rev., C; 3: 337-44(Jan 1971).

The (d,p) reaction on ^{102}Ru and ^{104}Ru has been studied at an incident deuteron energy of 14 MeV. Proton spectra were recorded in a broad-range magnetic spectrograph. Transferred l values and spectroscopic factors were obtained by comparing the measured angular distributions with distorted-wave Born-approximation predictions. The low-lying levels of ^{103}Ru are in good agreement with the results of a recent (d,t) study; information on higher levels of ^{103}Ru and on all levels in ^{105}Ru is new. There is good correspondence between strongly excited levels in the two isotopes, although there is evidence of a higher level density in ^{105}Ru. The summed spectroscopic factors give information on the extent of filling of the neutron orbitals in the targets, and these results are in reasonable agreement with results from the (d,t) reaction and for other nuclei in this region. (auth)

34152 ENERGY LEVELS AND TRANSITIONS IN ^{197}Au FROM THE (n,n'γ) REACTION. Nelson, J. A. (Tulane Univ., New Orleans); Dave, V. R.; Wilenzick, R. M.; Palms, John M. Phys. Rev., C; 3: 307-12(Jan 1971).

The energy levels and transitions of ^{197}Au have been examined by high-resolution measurements of the γ rays from the (n,n'γ) reaction for incident neutrons between the energies of 0.2 and 2.2 MeV. The level scheme, up to an excitation of 1308 keV, is compared with a recent neutron time-of-flight study, and several new levels are proposed. Differential γ-ray production cross sections at 95° are given and spin and parity assignments for levels in this nucleus are discussed. (auth)

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Refer also to abstracts 33764, 33819, and 34084.

34153 (ANL–Trans–878) ON THE ASYMMETRIC DEFORMATION OF FISSIONING NUCLEI. Pashkevich, V. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). Translated for Argonne National Lab., Ill., from report JINR–P4-5581. 25p. Dep. NTIS.

An abstract of this paper, prepared from the original language, appeared as NSA 25: 23024.

34154 (COO–2061-10) ORIGIN OF THE SPIN-ORBIT INTERACTION. Signell, Peter (Michigan State Univ., East Lansing.

Dept. of Physics). 31 Aug 1970. 17p. (CONF-700811-14). Dep. NTIS.

From third international symposium on polarization phenomena in nuclear reactions; Madison, Wis. (31 Aug 1970).

The origin of the nuclear-shell-model spin–orbit splitting has been the object of a number of investigations. These are reviewed both as to origin in the two-body nuclear force and ultimately in terms of elementary-particle processes. (auth)

34155 (ITF-70-97-P) ON INVESTIGATION OF REACTIONS IN THE SYSTEM OF HEAVY NUCLEUS AND TWO NEUTRONS. Ol'khovskii, V. S. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1970. 12p. (In Russian). Dep. NTIS (U. S. Sales Only).

The problem of describing all possible transitions in the system of heavy-nucleus-plus-two-neutrons is considered under the condition that there is a coupled system of nucleus-plus-one-neutron and an incident neutron. For a rather wide class of conditions one can use the more simple equation of the Gell-Mann–Goldberger type instead of Faddeev's equation. The possibility of algebraizing the integral equations for the T matrix by expanding the function $V_{12}\Psi_i^{(+)}$ in terms of the total system of discrete functions is studied. Here V_{12} is the neutron interaction potential, and $\Psi_i^{(+)}$ is the total wave function of the system with the above-mentioned initial channel. The reasons why the function $V_{12}\Psi_i^{(+)}$ belongs to the class L^2 are presented. (auth)

34156 (JINR-E4-5711) ON POSSIBILITIES OF STUDYING THE STRUCTURE OF HIGHLY EXCITED STATES (RESONANCES) BY NEUTRON SPECTROSCOPY METHODS. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1971. 28p. Dep. NTIS (U. S. Sales Only).

The characteristics which are necessary for studying the structure of highly-excited nuclear states (resonances) are considered. It is shown that the possibilities of the time-of-flight techniques in neutron spectroscopy as applied to the study of the highly excited state structure become essentially richer if unstable nuclei and isomers are used as the targets. The increase of the state density with excitation energy and the dependence of the density on the mass number are explained qualitatively. On the basis of the data on the reduced widths for the S-neutron capture and the E1 transitions to the low-lying states, the contribution of few-quasiparticle components to the excited-state wave functions is estimated. The problem of correlations between the reduced neutron and radiative widths is studied and some cases are indicated in which one can expect large correlations. The problem of correlations between (n,γ) and (d,p) reactions is also considered. (auth)

34157 (LYCEN-6804) SOME METHODS USED IN THEORETICAL NUCLEAR PHYSICS. [SEMINAR HELD AT] AUSSOIS, FRANCE, FEBRUARY 26–MARCH 2, 1968. (Lyon Univ. (France). Institut de Physique Nucleaire). [nd]. 234p. (In French). (CONF-680220).

Some methods in theoretical physics which are currently used or seem promising are discussed. Six of the eight papers are abstracted. The remaining two papers have previously appeared in NSA. (France)

For abstracts of individual papers see: 34158–34163.

34158 (LYCEN-6804, pp 75-108) GRAPHIC METHOD FOR TREATING RACAH ALGEBRA. El-Baz, E. (Lyon Univ. (France). Institut de Physique Nucleaire). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

A graphic method of vectorial addition for nuclear physics problems is proposed; this method treats kinetic moment coupling and is based on a ket and bra representation. It is shown that the method enables a direct definition to be made of the Clebsch–Gordan coefficient and the 3j Wigner coefficient, and allows any analytic expression to be written down directly. The ket and bra representation renders the graphic method coherent in justifying the different graphic equivalents of the analytic expressions. The method extends to irreducible tensors, spherical harmonics, and rotation matrices, in the graphic representation. (auth)

34159 (LYCEN-6804, pp 109-24) USE OF THE GRAPHIC METHOD FOR CALCULATING A STRIPPING ANGULAR DISTRIBUTION. Fayard, C.; Lamot, G.; El-Baz, E.; Lafoucriere, J. (Lyon Univ. (France). Institut de Physique Nucleaire). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

The graphic method of N. Austern, R. M. Drisko, E. C. Halbert, and G. R. Satchler, (Phys. Rev, 133 (1964) B_1) of calculating the angular distribution of stripping reactions was considered. The calculation made was for the most general case, by considering a central interaction potential, independent of spin and of finite range giving a differential cross section with the geometric and physical parts separated. The particular case of (d,p) stripping with a deuteron in the S state was envisaged with the interaction range potential chosen to be zero. (auth)

34160 (LYCEN-6804, pp 125-52) NATURE OF THE NUCLEAR WAVE FUNCTIONS. Gillet, Vincent (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

Four particular problems which cover a wide range of modern theoretical spectroscopy are examined: the problem of correlations in the wave function of the fundamental state of complete two shell nuclei ^{12}C, ^{16}O, ^{40}Ca, and ^{208}Pb; the problem of the validity of the independent quasi particle image for even odd nuclei with a closed shell (^{43}Sc, ^{51}V, ^{53}Mn, ^{55}Ca, ^{57}Ni, ^{59}Ni, ^{61}Ni, ^{63}Ni, ^{65}Ni, ^{87}Rb, ^{89}Yt, ^{91}Nb, ^{93}Tc, ^{113}Sn, ^{117}Sn, ^{121}Sn, ^{125}Sn, ^{115}Sn, ^{119}Sn, ^{123}Sn, ^{197}Pb, ^{199}Pb, ^{201}Pb, ^{203}Pb, ^{205}Pb, ^{207}Pb, and ^{209}Pb; the problem of the nature of the wave function of the vibrational states of even even nuclei with a closed shell, and the problem of the microscopic structure of the rotation states of deformed nuclei with two unfilled shells. (France)

34161 (LYCEN-6804, pp 153-78) METHODS OF CALCULATION IN NUCLEAR MATTER THEORY. Oberlechner, Georges (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

The classical calculation techniques developed in the Brueckner–Bethe–Goldstone theory are presented. The basis of the theory is the reaction matrix G. The definition of G and the formal basis of the theory are recalled, that is to say, the Goldstone expansion. (France)

34162 (LYCEN-6804, pp 179-214) COUPLED EQUATIONS AND DWBA. Raynal, Jacques (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

It is shown that the DWBA may be generalized and iterated to give the same results as the coupled equations. The ECIS (coupled sequential iterated equations) method is compared with the DWBA method. Tests are discussed which have already been made on this method or which are to be carried out. (France)

34163 (LYCEN-6804, pp 215-31) MIGDAL METHOD. Rho, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). (In French).

From Seminar on some methods used in theoretical nuclear physics; Aussois, France (26 Feb 1968).

In Some methods used in theoretical nuclear physics.

The Migdal method which applies to nuclear structure the theory of the Fermi and Landau liquid is explained. It is shown that this method is no more phenomenological than other methods used in calculating nuclear structure. The theory is developed using Green functions. The static and dynamic moments of the fundamental states and the excited states with energies sufficiently below the Fermi energy are of particular interest. The excitation spectra obtained is very limited, this results from the hypotheses necessary to reduce the complexity of the N body problem. (France)

34164 ENERGY PER PARTICLE OF NEUTRON MATTER NEAR NUCLEAR DENSITY. Schlenker, Sara L.; Lomon, E. L. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., C: 3: 1487-91(Apr 1971).

The energy per particle of neutron matter in the density range 10^{13} to 10^{15} g/cm^3 was calculated self-consistently by using recent nuclear potentials: the Bressel–Kerman–Rouben potential and the boundary-condition model of Feshbach and Lomon. At low densities the results are in good agreement with other calculations of the energy density of neutron matter. At higher densities, the predicted energy density depends more strongly on the specific potential used. More recent potentials yield somewhat lower pres-

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sures for neutron matter (hence, a smaller mass range for neutron stars) than those predicted with the Levinger–Simmons potential, which has been used as the basis for calculations of neutron-star structure. (auth)

34165 MINIMAL SET OF INDEPENDENT RECURSION RELATIONS FOR SU(2) CLEBSCH–GORDAN COEFFICIENTS. Bose, A. K.; Patera, J. (Univ. of Montreal). Can. J. Phys.; 49: 947-50(1 Apr 1971).

It is shown that there are only two independent recursion relations between SU(2) Clebsch–Gordan coefficients from which all known recursion relations can be obtained. (auth) (Canada)

34166 TENSOR CORRELATIONS IN NUCLEAR MATTER. Ristig, M. L.; Ter Louw, W. J.; Clark, J. W. (Washington Univ., St. Louis). Phys. Rev., C; 3: 1504-13(Apr 1971).

The Jastrow method is extended to the treatment of tensor forces by the incorporation of suitable state dependence into the two-body correlation operator. The one- and two-body parts of the energy expectation value, developed in a factor-cluster (Van Kampen) expansion, are evaluated for nuclear matter. Numerical results are presented for three semirealistic hard-core potentials with differing mixtures of central and tensor components. These results point to the necessity for an examination of three-body cluster corrections to the energy expectation value. (auth)

34167 USE OF ATOMIC EMISSIONS FOR DETERMINING THE DURATION OF NUCLEAR REACTIONS. Poyarkov, V. A.; Prokopets, G. A.; Strizhak, V. I. (Kiev State Univ.). Ukr. Fiz. Zh. (Russ. Ed.); 15: 1912-14(Nov 1970). (In Russian).

The probability of using atomic excitation by a nucleus in which a reaction takes place, as a function of the duration of the reaction, for determining the duration of nuclear reactions of the order of 10^{16} to 10^{-26} sec is considered. The effect is analyzed for elastic scattering, and a trivial generalization was made for this effect for inelastic scattering. Experimental study of the possibility for observation of the effect was done by studying the coincidences of elastically scattered neutrons with x rays. An x-ray spectrometer was constructed for determining the prompt x-radiation of Pb and Bi specimens irradiated by a flux of 14-MeV neutrons. (R.V.J.)

34168 QUASIELASTIC NEUTRINO–NUCLEUS INTERACTIONS. Bell, J. S. (CERN, Geneva); Smith, C. H. Llewellyn. Nucl. Phys.; B28: 317-40(1971).

Calculations of the Pauli exclusion effect are made in a simple shell model. Shell structure effects, associated with spin-orbit splitting, appear, but are not large and decrease rapidly with increasing momentum transfer. The shell model remains less exclusive on the whole than the standard Fermi gas, but not sufficiently so to explain the apparent experimental absence of the exclusion effect. (auth)

34169 QUASI-PARTICLE EFFECTIVE INTERACTIONS. Plastino, A.; Vucetich, H. (Facultade de Ciencias Exactas, La Plata). Lett. Nuovo Cim.; 1: 491-4(20 Mar 1971).

A treatment similar to that of Bloch and Horowitz [Nucl. Phys., 8: 91 (1958)] for determining the shell-model effective-interaction Hamiltonian is formulated, but it is applied to Bogolyubov–Valatin quasi-particles (q.p.). In this case no difficulties associated with a core arise because one has to deal with only "valence" q.p. The only additional problem that must be faced is that of eliminating the spurious state resulting as a consequence of the violation of the conservation law for the number of particles induced by the q.p. transformation. This problem can be overcome by using the Schmidt orthogonalization method to obtain, from the original one, a basis spanning a subspace orthogonal to the spurious state. As an example, a simple model is considered in which 2Ω particles interact by means of the surface delta interaction and fill two levels of opposite parity, each of a degeneracy 2Ω and separated by an energy gap 2g. The formalism should allow calculations for deformed heavy nuclei using more realistic interactions than heretofore. It can also be used with spherical nuclei when one is working in a very large basis. (R.W.R.)

34170 CORRECTION TO THE FORMULA FOR THE RADIATIVE TAIL IN ELASTIC ELECTRON SCATTERING. Borie, E. (Univ., Frankfurt am Main). Lett. Nuovo Cim.; 1: 106-9(16 Jan 1971).

A theoretical expression for the radiative tail is obtained by integrating the Bethe–Heitler cross section for emission of a bremsstrahlung photon during the scattering process over the directions of the unobserved photon. Lowest-order corrections to the Bethe–Heitler formula are used, and the integration is done by means of the peaking approximation [Schiff, Phys. Rev., 87: 750 (1952)]. Values of the ratio of the cross section evaluated in first and second Born approximation are given as a function of Z and scattering angle. This ratio is the same for elastic scattering accompanied by bremsstrahlung, and it is independent of energy, for the assumptions used here. (R.W.R.)

34171 APPLICATION OF THE STATISTICAL THEORY TO HEAVY-ION REACTIONS. Abul-Magd, A. Y. (International Centre for Theoretical Physics, Trieste, Italy); El-Nadi, M. Phys. Rev., C; 3: 1645-9(Apr 1971).

The cross section of heavy-ion reactions is studied in the framework of the statistical theory of nuclear reactions. An expression is obtained for the probability of production of different isotopes in heavy-ion collisions. A comparison with experimental data is given. (auth)

34172 STUDY OF APPROXIMATIONS IN THE NUCLEAR PAIRING-FORCE PROBLEM. Bishari, M. (Weizmann Inst. of Science, Rehovot, Israel); Unna, I.; Mann, A. Phys. Rev., C; 3: 1715-19(Apr 1971).

The solvable two-level pairing model is used to test two new number-conserving approximations. These approximations are compared with the exact results, with perturbation theory, with the BCS method, and with the projected BCS method of Kerman, Lawson, and Macfarlane. It is found that second-order perturbation theory and one of the tested approximations work rather well for not too high values of the pairing-force strength, while for higher values the other approximation turns out to be quite good. (auth)

34173 MICROSCOPIC DESCRIPTION OF QUASIROTATIONAL BANDS. Marshalek, Eugene R. (Univ. of Notre Dame, Ind.). Phys. Rev., C; 3: 1710-15(Apr 1971).

A microscopic cranking model is introduced for vibrational nuclei; this extends the foundation for the phenomenological variable-moment-of-inertia model. The negative value of I_0 then emerges naturally. The cranking model approximates energies, static moments, and transition probabilities within the quasi-rotational subspace. An illustrative application is made to the exactly soluble Moszkowski model. (auth)

34174 CONVERGENCE OF THE SASAKAWA EXPANSION FOR THE SCATTERING AMPLITUDE. Coester, F. (Argonne National Lab., Ill.). Phys. Rev., C; 3: 525-9(Feb 1971).

Sasakawa has rewritten Schrödinger's integral equation in such a manner that the inhomogeneous term has the asymptotic behavior of the exact scattering wave function. This paper gives a proof that the iterative solution for the scattering amplitude converges for all local potentials for which the function rV(r) is absolutely integrable. Under very general conditions the kernel of the Sasakawa equation is a Hilbert–Schmidt kernel. The integral equation is convenient for numerical solution in both the radial representation and the momentum representation. (auth)

34175 EQUIVALENT LOCAL POTENTIALS OBTAINED FROM SEPARABLE TWO-NUCLEON INTERACTIONS. Arnold, Louis G.; MacKellar, Alan D. (Univ. of Kentucky, Lexington). Phys. Rev., C; 3: 1095-1104(Mar 1971).

A method of equivalent local potentials is applied to separable interactions which fit the $^1S_0$ two-nucleon phase shifts. The method of generating equivalent local potentials used in this paper is independent of the boundary conditions imposed on the solutions of the nonlocal equation; consequently, all solutions of the nonlocal equation lead to the same equivalent local potential. The uniqueness of the equivalent local potential obtained by the present method is considered to be useful for the purpose of understanding nonlocal interactions. The Yamaguchi, the one- and two-term Tabakin, and the case-IV Mongan potentials are studied. The equivalent local Yamaguchi potential is similar to low-energy local two-nucleon interactions which do not have short-range repulsion. The two-term Tabakin potential results in an equivalent local potential with short-range repulsion. The occurrence of spurious states in the one-term Tabakin potential is related to a class of zeros of this separable interaction in coordinate space. The case-IV Mongan potential results in an equivalent local potential with strong short-range attraction. Further study of this interaction revealed a spurious state at 19.6 BeV which causes the wave function to have an additional node at experimentally relevant energies. The paper is concluded with an examination of the problem of constructing separable interactions which have short-range repulsion. It is shown that such interactions have a pronounced tendency to produce spurious states. (auth)

34176 OFF-SHELL CONTINUATIONS OF THE TWO-PARTICLE TRANSITION MATRIX WITH BOUND STATES. Kowalski, K. L.; Monahan, J. E.; Shakin, C. M.; Thaler, R. M. (Case Western Reserve Univ., Cleveland. Argonne National Lab., Ill.). Phys Rev., C; 3: 1146-51(Mar 1971).

The general framework of a recent proposal for constructing classes of two-particle off-shell transition matrices consistent with given bound-state binding energies and a given set of phase shifts for all energies is presented. This establishes certain properties of the underlying potential which previously needed to be assumed. The large arbitrariness in the choice of bound-state wave functions and the lack of correlation, in general, between the choice of bound-state wave functions and the values of the binding energies are demonstrated. A specific method for actually executing the construction program is proposed which should be useful when there exists reason to prefer a particular bound-state wave function. (auth)

34177 SIMPLE AND EXACT METHOD FOR CALCULATING NUCLEAR REACTION MATRIX. Barrett, B. R. (Univ. of Pittsburgh); Hewitt, R. G. L.; McCarthy, R. J. Phys. Rev., C; 3: 1137-45(Mar 1971).

A new, simple, and exact method is given for calculating the reaction matrix G in a two-particle harmonic-oscillator basis. The method makes use of an expansion of the Bethe-Goldstone wave function in terms of solutions of the Schrödinger equation for two interacting particles in a harmonic-oscillator well. Since a two-particle basis is used, the Pauli operator Q is diagonal and can be treated exactly. Reaction matrix elements based on the Hamada–Johnston potential are used in a shell-model calculation of A = 18 nuclei. The results are compared with those of earlier calculations using approximate Pauli operators. The dependence of the reaction matrix on the starting energy is studied, and the relationship of this energy to the intermediate-state spectrum and to the Pauli operator Q is discussed. In this same context the difference between using a Brueckner Q and a shell-model Q is also discussed. (auth)

34178 MEASUREMENT OF THE MAGNITUDE AND SIGN OF THE NUCLEAR QUADRUPOLE INTERACTION VIA THE SPIN PRECESSION OF AN ANGULAR CORRELATION. Grodzins, L.; Klepper, O. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Phys. Rev., C; 3: 1019-23(Mar 1971).

Perturbed angular-correlation techniques are proposed for measuring the spin precessions of a polarized nucleus interacting with an axially symmetric electric field gradient. A specific method is suggested which makes use of Coulomb excitation to polarize and excite a nuclear state even as it recoils the nucleus into a suitable crystalline environment. Calculations indicate that this spectroscopic technique should make practical the measurements of the sign and magnitude of quadrupole moments of subnanosecond nuclear states. (auth)

34179 TREATMENT OF TWO-PARTICLE CONTINUUM STATES IN THE SHELL-MODEL APPROACH TO NUCLEAR REACTIONS. Fuller, R. C. (Univ. of Minnesota, Minneapolis). Contract AT(1-11)-1764. Phys. Rev., C; 3: 1042-57(Mar 1971).

To consider deuteron-induced reactions within the shell model, it is necessary to include single-particle states with two particles in continuum single-particle states. Expressions are derived for operators whose matrix elements give the transition amplitudes for the processes encountered in deuteron-induced reactions. Each of these operators can be written in terms of a single operator which satisfies an integral equation whose kernel involves the Green's function for two noninteracting particles in the presence of a common potential. This operator is discussed at length. Using single-particle Gamow states, a method is formulated to approximate the connected part of this operator by an operator of finite rank. This approximation is then tested numerically and is found to be effective. Finally, there is a discussion of the implications of the approximation in the scattering amplitudes of interest. (auth)

34180 CONNECTION BETWEEN THE IWAMOTO-YAMADA CLUSTER EXPANSION AND THE REACTION-MATRIX PERTURBATION THEORY. Wong, Chun Wa (Univ. of California, Los Angeles). Phys. Rev., C; 3: 1058-64(Mar 1971).

A partial-wave decomposition of the Iwamoto–Yamada cluster energy E_2 is used to show that the cluster energy $E_1 + E_2$ is consistently more attractive than the reaction-matrix energy $W_1 + W_2$ by several MeV per nucleon at all densities. The difference between these two types of calculations is shown to come from the absence in E_2 of the dispersion effect in W_2 due to self-consistent hole energies. The necessity for imposing subsidiary conditions on the correlation function for E_2—conditions not explicitly required in reaction-matrix calculations—is traced to the absence of the same dispersion effect. This result suggests a possible starting point for a formal comparison of the two expansions. (auth)

34181 PROBLEMS ASSOCIATED WITH THE FITTING OF LOW-ENERGY SPECTRA IN A TRUNCATED VECTOR SPACE. Ullah, N.; Trainor, L. E. H. (Univ. of Toronto). Phys. Rev., C; 3: 998-1003(Mar 1971).

It is shown that it is possible to fit the low-energy spectrum in a truncated space using any one of a variety of pseudo-Hamiltonians together with a suitable choice of a set of orthonormal wave functions. Numerical examples are used for illustration. (auth)

34182 STUDY OF THE NEUTRON–PROTON INTERACTION. Basu, M. K.; Banerjee, D. (University Coll. of Science, Calcutta). Phys. Rev., C; 3: 992-7(Mar 1971).

Systematics of n-p interaction energies I_{np}, obtained from a linear combination of nuclear binding energies, are discussed. The calculated I_{np} values show evidence of shell effects. A closed expression, connecting n-p interaction energies with nuclear size and spin, is given for even–even nuclei. (auth)

34183 METHODS OF STUDYING THE STRUCTURE OF THE ATOMIC NUCLEUS. Solov'ev, V. G. At. Energ. (USSR); 30: 37-43(Jan 1971). (In Russian).

Difficulties in studying nuclear structure are associated with the necessity of describing a system with a finite number of strongly interacting particles in the absence of a parameter indicating the smallness of the system. Nuclear theories can be divided into three types: phenomenological, semi-microscopic and microscopic. In the phenomenological description of the structure of complex nuclei, collective coordinates characterize the deviation in form of the nucleus from that of a sphere, and the excitations of the nucleus are associated with rotation of the nucleus as a whole and with oscillations of the surface of the nucleus. Each nucleus is characterized by a number of parameters. The excitation energy of states, their multipole moments and electromagnetic transition probabilities are expressed through these parameters which in turn are derived from experimental data. This approach shows some serious limitations. The semi-microscopic description is based on selecting the effective nuclear interaction which is divided into two parts: that of the average field of the nucleus, and the residual interactions. The average field is the potential created by all the nucleons of the nucleus, and is derived from a great body of experimental data. The residual interactions vary slowly from nucleus to nucleus; they are not small, and cannot be accounted for by perturbation theory. The average field determines the concrete properties of each nucleus, and is responsible for differences in nuclear properties. Relative rather than absolute characteristics of a nucleus are described. The energy of an excited state rather than the total energy of the nucleus can be calculated. A good description of low-lying excited states of average and heavy nuclei has been obtained by a superfluid model of the nucleus. The microscopic description is based on the use of experimental data of nucleon–nucleon scattering in order to calculate such basic properties as the density of nuclear material and the binding energy of a nucleon in the nucleus. Calculations have been extended to higher and higher excited states, and the range of nuclei have also been extended to superheavy nuclei and to elements far from the beta-stability line. Strongly deformed nuclei are considered. Methods have been developed to calculate the magnitude of the contribution of impurity from higher configurations in quasi-particle and phonon states. These methods are reviewed. (22 references) (TTT)

34184 GROUP-THEORETICAL DECOMPOSITION OF EFFECTIVE INTERACTIONS IN THE fp-SHELL. Pluhar, Z. (Technische Univ., Brunswick). Phys. Lett.; 34B: 475-7(29 Mar 1971).

The effective two-particle interaction suggested by Kuo and Brown is decomposed into irreducible parts being classified according to the Elliott SU(3) classification scheme. In this expansion, central operators preserving spatial symmetry are dominating, the components preserving the classification scheme are large. (auth)

34185 INTRABAND BE2-RATIOS BY ANGULAR PROJECTED K = 0 STATES. Frauendorf, S.; Janssen, D.; Muenchow, L. (Zentralinstiut fuer Kernforschung, Rossendorf, Ger.). Phys. Lett.; 34B: 469-71(29 Mar 1971).

The matrix elements of the Hamiltonian and the electric quadrupole operator with angular momentum projected states are parametrized to get expressions for the spectrum and the ratio $BE2(I \rightarrow I\text{-}2)/BE2(2 \rightarrow 0)$ depending on few parameters only. By

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appropriate choice of these parameters the experiments can be reproduced with satisfying accuracy. (auth)

34186 α AND γ DECAYS OF HIGH EXCITED STATES OF COMPLEX NUCLEI. Solov'ev, V. G. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz.; 13: 48-59(Jan 1971). (In Russian).

The possibility of obtaining information on the structure of states of complex nuclei with the excitation energies close to the nucleon binding energy or larger than it from experimental data on (n,α) and (n,γ) reactions with the resonance excitation is investigated. The wave function of high energy state is constructed and the matrix elements are calculated for α and γ transitions from highly excited states to the ground, one-phonon and two-quasiparticles ones. It is shown that α and γ transitions involve a small number of components of the wave function of the highly excited state. Thus the experimental data on the reduced probabilities of α and γ transitions can give some information on the values of certain components of the wave function of highly excited states. (auth)

34187 MAGNETIC DIPOLE MOMENTS OF $p_{1/2}$-SHELL NUCLEI. Hsieh, S. T. (National Tsing Hua Univ., Hsinchu, Taiwan). Phys. Rev., C; 3: 1220-2(Mar 1971).

The magnetic dipole moments of $p_{1/2}$-shell nuclei are calculated by the first-order perturbation theory. It is shown that the tensor force which causes the configuration mixing is important to explain observed data of these moments. (auth)

34188 STRUCTURE EFFECTS OF COLLECTIVE KINETIC ENERGY OF THE NUCLEUS IN PHENOMENOLOGICAL MODELS. Rumyantsev, B. A. (Inst. of Nuclear Physics, Novosibirsk, USSR). Yadern. Fiz.; 13: 69-72(Jan 1971). (In Russian).

Corrections are calculated to the spectra and E2-transition probabilities for two phenomenological models: an axial-nucleus model and a model with a γ-unstable potential. The difference between the real collective Hamiltonian and the conventional hydrodynamic expression is treated as a perturbation. (auth)

34189 DESCRIPTION OF COLLECTIVE MOTION WITH THE PROJECTION METHOD. Frauendorf, S.; Janssen, D.; Muenchow, L. (Central Inst. for Nuclear Research, Rossendorf, Ger.). Yadern. Fiz.; 13: 60-8(Jan 1971). (In Russian).

A scheme to calculate spectra of even–even deformed nuclei by means of the projection method is considered. The relation to the Bohr–Mottelson wave function is established; it is shown that in such an approach the coupling of the internal states is taken into account automatically. A generalization of the method is discussed in which the projected functions became eigenstates in a limited basis. (auth)

34190 MIXED CONFIGURATION SHELL MODEL CALCULATIONS FOR NUCLEI WITH N = 28, $20 < Z \leq 28$. Lips, Kathleen Elizabeth. Lexington, Ky.; Univ. of Kentucky (1970). 75p. University Microfilms Order No. 71-4130.

Thesis.

Several simple mixed-configuration shell models are used to calculate energy levels, γ-ray transition rates, and proton spectroscopic factors for the nuclei with N = 28 and $20 < Z \leq 28$. First, the method of effective interactions is used to construct wave functions for a model in which only states of the configurations $(1f_{\frac{7}{2}}^n)$ and $(1f_{\frac{7}{2}}^{n-1}2p_{\frac{3}{2}})$ are allowed. The $1f_{\frac{7}{2}}$ single-particle energy and the ten two-body matrix elements are considered adjustable parameters and are varied until the eigenvalues of the energy matrices give the best least-squares fit to twenty-five well established experimental levels. Level energies, γ-ray transition rates, and proton spectroscopic factors calculated with the resulting eigenfunctions are compared to experimental data for forty-three levels in seven nuclei, including properties of levels which were not included in the least-squares fitting. The calculated and measured energies and spectroscopic factors are found to be in good agreement, but the calculated M1 transition rates are too slow by factors ranging from four to twenty. In order to improve the transition rates the model space is expanded to include states of the configuration $(1f_{\frac{7}{2}}^{n-1}1f_{\frac{5}{2}})$ as well as the $(1f_{\frac{7}{2}}^n)$ and $(1f_{\frac{7}{2}}^{n-1}2p_{\frac{3}{2}})$ states. Additional two-body matrix elements required for the rediagonalization of the energy matrices are calculated with a modified surface delta function (MSDI) residual interaction fitted to the effective interactions obtained in the first calculation. This model provides a good fit to the M1 transition rates without altering the successes of the previous calculation. Over the entire shell good agreement is obtained between theoretical and measured energies, transition rates, and spectroscopic factors wherever the data permit meaningful comparisons. The calculation with the expanded model was repeated using instead of the MSDI matrix elements the reaction matrix elements of Kuo and Brown. The results are similar to those of the calculation with the MSDI matrix elements, but they are not as successful, particularly for the nuclei higher in the shell. (Diss. Abstr. Int., B)

34191 INVESTIGATION OF NUCLEAR DEFORMATION BY MEANS OF THE K-HARMONICS METHOD. Gorbatov, A. M.; Demin, V. F.; Pasynkov, I. G. (Inst. of Atomic Energy, Moscow). Yadern. Fiz.; 13: 314-20(Feb 1971). (In Russian).

Mathematical apparatus is developed which allows one to take into account the ellipsoidal nuclear deformation by means of variation parameters. The axial-symmetrical deformation of ^{16}O is considered as a model problem. The role of different energies in the variation of the form of nucleus is investigated. (auth)

34192 ANTISYMMETRIZED DISTORTED WAVE THEORY OF INELASTIC NUCLEON SCATTERING. Geramb, H. V.; Amos, K. A. (Univ. of Georgia, Athens). Nucl. Phys.; A163: 337-77 (1971).

Transition amplitudes for inelastic nucleon scattering from nuclei are developed using an antisymmetrized distorted wave approximation. Nuclear states are specified by a microscopic model of nuclear structure. The transition operator includes central tensor and core polarization terms. A collective model approximation is used to define the core polarization contribution. The central force has a Yukawa form while the tensor force is chosen to have a modified Yukawa shape. Inelastic proton scattering to the first excited state of ^{89}Y is analyzed for incident energies of 18.8, 24.5 and 61.2 MeV. In addition, analysis of the inelastic scattering of 61.4 MeV protons to the 5^- state of ^{90}Zr at 2.315 MeV excitation is reported. Good fits to the data are obtained. Large effects due to exchange matrix elements are noted. Strong variations in results are seen when the central interaction singlet and triplet strengths are varied. The tensor force plays an important role in modifying the triplet contributions. For the triplet odd channel required in our analysis, tensor force matrix elements are 10% of the central force values. With a more realistic form, this is expected to increase and may be 30%. The fits at lower energy require a density dependence of the effective interaction. This complements such requirements in recent spectroscopy studies. Also the importance of small-amplitude configuration mixing is evident. The core polarization contributions that represent the summation of such terms are necessary features of the analyses. This is particularly so in the analysis of the ^{90}Zr reaction. (auth)

34193 SOME CONSIDERATIONS ON USING THE COMPARISON PROCEDURE TO EXTRACT TWO-NUCLEON SCATTERING PARAMETERS FROM FINAL-STATE INTERACTIONS. Hungerford, E. V. (Rice Univ., Houston, Tex.). Nucl. Phys.; A163: 523-33(1971).

An investigation of the comparison procedure to extract two-nucleon scattering parameters from final-state interactions is presented. This investigation indicates when the approximations involved may be valid. It also points out clearly why the Watson–Migdal approximation does not always lead to correct results. (auth)

34194 CORE POLARIZATION OF THE EFFECTIVE TWO-NUCLEON INTERACTION FOR DIFFERENT DESCRIPTIONS OF THE CORE. Osnes, E. (Univ. of Oslo. State Univ. of New York, Stony Brook); Kuo, T. T. S.; Warke, C. S. Nucl. Phys.: A168: No. 1, 190-210(1971).

The core polarization of the effective two-nucleon interaction is studied for different descriptions of the core degrees of freedom, viz. perturbation theory, the Tamm–Dancoff approximation (TDA) and the random phase approximation (RPA). The core states were calculated both for a bare particle-hole interaction and for a renormalized one, in which the self-screening of the exchange term is the most important component. For the bare particle-hole force TDA and RPA give low-lying, collective 0^+ and 2^+ core phonons and lead to significant renormalization of the two-nucleon interaction. Screening of the particle-hole interaction serves to push up these core phonons and reduce the core-polarization effect on the two-nucleon interaction. The core polarization obtained for the screened RPA is close to the one obtained for the bare TDA. (auth)

34195 ALLOWED VALUES OF COUPLED ANGULAR MOMENTUM AND i-SPIN FOR NUCLEONS IN A SINGLE SHELL IN j–j COUPLING. Hubbard, Lincoln B. (Oak Ridge National Lab., Tenn.). Comput. Phys. Commun.; 1: 453-6(Dec 1970).

The program JNTJN calculates the number of allowed eigenfunctions in the representation of coupled i-spin and angular momentum; i.e., the number of eigenvectors for each pair of T and J values is calculated. The program enumerates the allowed values for the

projections, M_j and M_T, of the coupled angular momentum and i-spin. From these projections the allowed eigenvalues of J and T are readily found. The program is written in H-level Fortran IV for the IBM 360/75 or 360/91 and requires 16,500 32-bit words of storage. Compile time is about 1.5 seconds. The complete enumeration of the lower half of the $j = 3/2, 5/2, 7/2$, and $9/2$ shells requires 35 seconds on the 360/91. (R.W.R.)

34196 MULTIPOLE EXPANSION OF REALISTIC EFFECTIVE INTERACTIONS IN NUCLEI. Owen, L. W. (Oak Ridge National Lab., Tenn.). J. Comput. Phys.; 7: 182-6(Feb 1971).

When a realistic nucleon–nucleon interaction with a repulsive core is otherwise attractive, a fair approximation to the corresponding effective interaction is obtained by using the Moszkowski–Scott separation method in lowest order, which gives just the long-range part of the free two-nucleon interaction. This results in an exponential-like outer region with a cutoff at the separation distance. The technique of fitting such a truncated potential is discussed, and an algorithm for calculating the multipole coefficients of each term is derived. The method is a fast, accurate means of generating the multipole components of realistic interactions in nuclei. (R.W.R.)

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REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 32161, 32755, 32759, 32761, and 34346.

34197 (JPRS-53069, pp 56-63) DISTRIBUTION OF DEPOSITS AND ACTIVITY ON SURFACES OF EQUIPMENT AND CONNECTING LINES OF THE VK-50 SINGLE-CIRCUIT REACTOR. Rozhdestvenskaya, L. N.; Zabelin, A. I.; Chechetkin, Yu. V.; Lavrinovich, Yu. G.; Svyatysheva, T. S. Translated from At. Energ. (USSR); 30: 122-6(1971).

Radioactivity levels in the cooling system of the VK-50 power reactor are tabulated. The coolant loop water chemistry is described, and activity levels from specific isotopes are summarized. (H.D.R.)

34198 (JPRS-53069, pp 74-82) SOME PROBLEMS OF THE PHYSICS OF THE REACTORS AT THE BELOYARSKAYA AEPS. Vikulov, V. K.; Mityaev, Yu. I.; Shuvalov, V. M. Translated from At. Energ. (USSR); 30: 132-7(1971).

The two units of the Beloyarsk nuclear power plant are graphite-moderated boiling water reactors with nuclear superheat. The loading characteristics of the fuel channels to attain uniform power production across the cores are described. (H.D.R.)

34199 (JPRS-53069, pp 107-17) DESIGN OF URANIUM-GRAPHITE CHANNEL REACTORS WITH TUBULAR FUEL ELEMENTS AND NUCLEAR STEAM SUPERHEATING. Dollezhal, N. A.; Aleshchenkov, P. I.; Bulankov, Yu. V.; Knyazeva, G. D. Translated from At. Energ. (USSR); 30: 149-55(1971).

The designs of the cores and fuel element channels of the Beloyarsk superheat reactors are described and compared to designs for a conceptual 800 to 1000 MW(e) reactor producing supercritical steam. (H.D.R.)

34200 (JPRS-53069, pp 118-23) WATER-CHEMICAL MODE AT AEPS WITH CHANNEL REACTOR AND NUCLEAR STEAM SUPERHEATING. Konovalova, O. T.; Kocheleva, T. I.; Gerasimov, V. V.; Zhuravlev, L. S.; Shchapov, G. A. Translated from At. Energ. (USSR); 30: 155-8(1971).

The water and steam quality requirements for unit 2 of the Beloyarsk Nuclear Power Plant are discussed. (H.D.R.)

34201 (JPRS-53069, pp 236-44) POST-REACTOR STUDIES OF FUEL ELEMENTS FOLLOWING 626 EFFECTIVE DAYS OPERATION IN THE CORE OF THE VVER-1 REACTOR OF THE NOVO-VORONEZHSKAYA AEPS. Belokopytov, V. S.; Votinov, S. N.; Pakhomov, Z. I.; Deribizov, M. D.; Gabeskiriya, V. Ya.; Portnov, V. F. Translated from At. Energ. (USSR); 30: 222-6 (1971).

Two fuel elements consisting of uranium dioxide fuel in zirconium-niobium cans were irradiated for 626 days in the Novo Voronezh power reactor. The results of cladding structural studies and mechanical properties tests and fuel properties and burnup determinations are presented. (H.D.R.)

34202 FABRICATION OF THE AGRS. Greener, P. Weld. Metal. Fabr.; 39: 116-21(Apr 1971).

The fabrication and erection systems used for the liners, gas baffles, and diagrids built for the advanced gas-cooled reactor power stations, Hinkley Point B and Hunterston B, are described. (auth) (UK)

34203 TRANSACTIONS OF THE SEVENTH WORLD ENERGY CONFERENCE, MOSCOW, 1968. VOLUME 11. SECTION C3. ATOMIC POWER STATIONS. Moscow; Soviet National Committee on International Nuclear Power Conference (1969). 429p. (In several languages). (CONF-680829-(Vol.11)).

Papers are presented which review the achievements of nuclear technology, its fast rate of development, and the various technical and economic aspects of different reactor types. Topics discussed include: development of dual-purpose power and desalination plants; utility system operation with nuclear plants; nuclear power plant operation; operation of San Onofre power plant; development of nuclear power plants in Japan; plutonium availability and use; operating experience of U. S. nuclear power plants; breeder reactor development in the U. S.; Phenix fast reactor concept; development of thorium fuels; and development programs for nuclear power in Mexico and Czechoslovakia. (H.D.R.)

34204 TRANSACTIONS OF THE SEVENTH WORLD ENERGY CONFERENCE, MOSCOW, 1968. VOLUME 12. SECTION C3. ATOMIC POWER STATIONS. Moscow; Soviet National Committee on International Nuclear Power Conference (1969). 428p. (In several languages). (CONF-680829-(Vol.12)).

Progress in the development of nuclear power is reviewed, and some of the technical and economic problems in the nuclear power industry are examined. Papers are presented on: problems of electric power generation with fossil fuels in the U. S.; role of breeder reactors in U. S. utility planning; gas turbines for use with gas cooled reactors; automatic control of Canadian heavy water reactors; gas cooled reactor development in the U. K.; performance and economics of Canadian heavy water reactors; fast breeder reactor development in the U.S.S.R.; design of the BN-600 fast reactor; analysis methods for nuclear power costs; gas turbine blowers for gas cooled reactors; use of uranium in the U. K.; fast breeder reactor development in Germany; and small and medium-size nuclear power plant development. (H.D.R.)

34205 TRANSACTIONS OF THE SEVENTH WORLD ENERGY CONFERENCE, MOSCOW, 1968. VOLUME 13. SECTION C4. NEW SOURCES AND METHODS OF PRODUCING ELECTRICITY. Moscow; Soviet National Committee on International Nuclear Power Conference (1969). 469p. (In several languages). (CONF-680829-(Vol.13)).

Trends in the development of methods of electric power generation are examined, and the need for increasing the efficiency and lowering the cost of power generation is discussed. Methods other than the conventional steam and gas turbogenerator plants are described and their potential for development is analyzed. The most promising method appears to be the use of magnetohydrodynamic generators. Other methods investigated include: solar energy conversion, geothermal energy; storage batteries; fuel cells; and desalination by freezing. (H.D.R.)

34206 CHARACTERISTIC PROBLEMS IN PLANNING AND ENGINEERING NUCLEAR STATIONS INTEGRATED INTO POWER SYSTEMS. Sani, L.; Valtorta, M. (Ente Nazionale per l'Energie Elettrica, Rome). pp 219-230 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

On the basis of the experience gained through the operation of nuclear power plants, some technical and economic aspects which must be taken into account both in planning the construction of new nuclear power stations and in considering their future operation are analyzed. Special attention is devoted to the problems connected with the adoption of high capacities, with the peculiarities of nuclear fuel, with the safety of plants and the environmental characteristics of their location. 7 references. (auth)

34207 CHINSHAN UNIT NO. 1. FIRST NUCLEAR POWER PROJECT IN TAIWAN. Shen, C. H. (Taiwan Power Co., Taipei). pp 299-312 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

In 1970 the Taiwan Power Company of the Republic of China contracted with General Electric Company for the supply of one complete 1775-MW(t) BWR nuclear steam supply system and fuel fabrication services of its first core. The Taiwan Power Company has also contracted with the Westinghouse Electric International Company for the supply of one 636-MW(e) turbine generator set to match the NSSS equipment. The Taiwan Power Company has also engaged Ebasco Services Incorporated as the architect-engineer for this project. This nuclear plant, being the first of its kind in Taiwan, will be located in a sea-coast valley at the northern tip of the island. Site preparation will be started in late 1970 and excavation is scheduled for the middle of 1971. According to the construction schedule, the station will be in operation in 1975. A brief report on the project status is presented. (auth)

34208 UCPTE EXPERIENCE IN OPERATION AND INTEGRATION OF POWER STATIONS. Bauer, L. (Union de Coordination de la Production et du Transport de l'Electricite, Rome). pp 705-10 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power

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stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The Union for Co-ordinating Production and Transport of Electricity (UCPTE), of which eleven West European countries are members, is responsible for an interconnected system with a capacity exceeding 100 million kW and is familiar with the difficulties of integrating large power stations into an electric power system: in addition to the construction of high-tension lines, it is necessary to provide control, safety and other equipment. The experience which UCPTE has gained with nuclear power stations is reassuring: the latter have many advantages as well as some disadvantages. It is certain that, in the future as in the past, nuclear power stations will be able to provide all consumers with sufficient electrical energy under optimum safety and reliability conditions and at a reasonable price. (auth)

34209 HYDRO-THERMAL PROGRAM FOR THE PACIFIC NORTHWEST REGION OF THE UNITED STATES. Goldhammer, B. (Dept. of Interior, Portland, Oreg.). pp 711-22 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

A unique plan known as the "Hydro-Thermal Program" has been developed by non-Federal utilities and the Federal Government through the Bonneville Power Administration (BPA) for the transition from a hydro to a hydro-thermal system. Operations and planning are now co-ordinated among the four investor-owned utilities, 104 publicly and co-operatively owned systems, and BPA, who make up the Joint Power Planning Council, the guiding voluntary agency for implementing the Hydro-Thermal Program. The Joint Power Planning Council took two years to work out the program, defining roles of participants as follows: The Federal Government will add peaking capacity at existing dams; provide forced-outage reserves; build extra-high voltage transmission; provide surplus energy with an equitable sharing of the fuel savings; maintain a region-wide reserve for unanticipated load growth; and acquire the public systems' share of thermal plants. Cost of this thermal power will be pooled with the hydro from the Federal system and sold at a uniform postage stamp rate to public systems, co-operatives, Federal agencies, and large industry. Non-Federal utilities will build and finance the thermal plants, most of which will be jointly owned; provide lower voltage transmission and distribution facilities. This unique co-operative plan is under way, with a number of the complex contracts already written. (auth)

Operation and Economics

34210 (DOCKET-1155-114) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, February 1971. (Dairyland Power Cooperative, La Crosse, Wis.). 19 May 1971. Contract AT(11-1)-851. 26p. (DPC-851-23). Dep. NTIS.

34211 (DOCKET-50003-72) INDIAN POINT STATION, UNIT NO. 1. Core B, Fourth Cycle Refueling Program. (Consolidated Edison Co. of New York, Inc., New York). Apr 1971. 28p. Dep. NTIS.

34212 (DOCKET-50010-87) DRESDEN NUCLEAR POWER STATION, UNIT 1. Defective Motor Operator on Emergency Condenser System Valve. (Commonwealth Edison Co., Chicago, Ill.). 13 May 1971. 2p. Dep. NTIS.

34213 (DOCKET-50029-151) YANKEE NUCLEAR POWER STATION. Operation Report No. 124, April 1971. (Yankee Atomic Electric Co., Westboro, Mass.). 21 May 1971. 8p. Dep. NTIS.

34214 (DOCKET-50219-133) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. On-Site Diesel Generator Operability. (Jersey Central Power and Light Co., Morristown, N. J.). 20 May 1971. 3p. Dep. NTIS.

34215 (DOCKET-50237-164) DRESDEN NUCLEAR POWER STATION, UNIT 2. Failure of Core Spray Discharge Valve to Open on Test. (Commonwealth Edison Co., Chicago, Ill.). 3 Apr 1971. 2p. Dep. NTIS.

34216 (DOCKET-50237-165) DRESDEN NUCLEAR POWER STATION, UNIT 2. Diesel Generator Failed to Build Voltage on Test. (Commonwealth Edison Co., Chicago, Ill.). 5 Apr 1971. 2p. Dep. NTIS.

34217 (DOCKET-50245-57) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Operation Report, October-December 1970. (Millstone Point Co., Hartford, Conn.). 45p. Dep. NTIS.

34218 (DOCKET-50245-82) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Core Spray and Low Pressure Coolant Injection System Valves Malfunction Incident. (Millstone Point Co., Hartford, Conn.). 17 May 1971. 12p. Dep. NTIS.

34219 (DOCKET-50255-39) PALISADES PLANT. Difficulty with the Primary Coolant Pumps. (Consumers Power Co., Jackson, Mich.). 18 May 1971. 4p. Dep. NTIS.

34220 (DOCKET-50255-40) PALISADES PLANT. Primary System Leak Caused by Temporary Test Instrument Installation. (Consumers Power Co., Jackson, Mich.). 18 May 1971. 3p. Dep. NTIS.

34221 (DOCKET-50263-70) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Inoperability of Main Steam Line High Flow Sensors. (Northern States Power Co., Minneapolis, Minn.). 12 May 1971. 2p. Dep. NTIS.

34222 (DOCKET-50263-71) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Diesel Generator Failure to Start. (Northern States Power Co., Minneapolis, Minn.). 18 May 1971. 3p. Dep. NTIS.

34223 (DOCKET-50263-72) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Unusual Occurrences: April 20, 1971, April 26, 1971, and May 2, 1971. (Northern States Power Co., Minneapolis, Minn.). 19 May 1971. 4p. Dep. NTIS.

Operations incidents described include: isolation of condenser low vacuum scram pressure switch on April 20, 1971; slow closure of main steam isolation valve on April 26, 1971; and automatic pressure relief system backup power supply fuses missing on May 2, 1971. (D.C.C.)

34224 (EUR-4595) 50 MWe DODEWAARD NUCLEAR POWER PLANT. Annual Report, 1969. (Gemeenschappelijke Kernenergiecentrale Nederland N. V., Dodewaard. Samenwerkende Electriciteits-Productiebedrijven, N. V., Arnhem (Netherlands)). 14 Oct 1970. 24p. (In Dutch). Dep. NTIS (U. S. Sales Only). EUR F1.3.

Activities of the personnel relating to the operation of the plant are described. A financial report follows. The operation of the plant is then discussed. Reactor system availability was 99.9% in 1969. Owing to the saturated steam produced by the reactor, the availability of the whole plant over the same period was only 73.5%. There were eight scheduled shut-downs, two for extended periods of modifications to the turbine drains, and 18 unscheduled shut-downs, eight of them due to the problems with turbine drains. Gross electrical output for the year was 315.49 GWh. The average core burnup at the end of 1969 was 4 914 MWd/tU. A brief review of the reactor physics is presented. (auth)

34225 (JPRS-53069, pp 25-46) BASIC OPERATIONAL CHARACTERISTICS OF NEW REACTOR UNIT GIVEN. Voronin, L. M.; Ovchinnikov, F. Ya.; Samoylov, S. N.; Malkov, Yu. V.; Sedov, V. K.; Markov, Yu. V.; Dukhovenskii, A. S.; Belyaev, A. I. Translated from At. Energ. (USSR); 30: 105-16(1971).

The second unit of the Novo Voronezh Nuclear Power Plant is described. It consists of a water cooled reactor producing 365 MW(e). The design parameters of the first core are discussed, and startup tests are described. Initial operating experience of the reactor is summarized. (H.D.R.)

34226 (JPRS-53069, pp 47-55) EXPERIENCE OF OPERATION OF ATOMIC ELECTRIC POWER STATION AT REINSBERG. Mentzel, S. Translated from At. Energ. (USSR); 30: 116-22 (1971).

The first 4 years operating experience with the Rheinsberg Nuclear Power Plant is summarized. The plant stability, power production, fuel utilization, availability, and radioactive emissions are discussed. (H.D.R.)

34227 (JPRS-53069, pp 83-95) STARTING METHODS AND EXPERIENCE IN OPERATION OF URANIUM-GRAPHITE CHANNEL TYPE REACTORS WITH TUBULAR FUEL ELEMENTS AND NUCLEAR SUPERHEATING OF STEAM. Aleshchenkov, P. I.; Zvereva, G. A.; Knyazeva, G. D.; Kononov, V. I.; Lunina, L. I.; Mityaev, Yu. I.; Nevskii, V. P.; Polyakov, V. K. Translated from At. Energ. (USSR); 30: 137-44(1971).

The nuclear steam supply systems of the two units of the Beloyarsk Nuclear Power Plant are described. Startup and operating experience with the reactors is presented. (8 references) (H.D.R.)

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34228 (JPRS-53069, pp 124-30) PREPARATION FOR STARTUP OF THE A-1 ATOMIC ELECTRIC POWER STATION. Khorvat, E. Translated from At. Energ. (USSR); 30: 158-62 (1971).

The planned startup program for the first Czechoslovakian power reactor, the A-1, is described. The stages of the startup program include equipment testing, core loading, zero power tests, and power tests. (H.D.R.)

34229 (STI/PUB-266) ECONOMIC INTEGRATION OF NUCLEAR POWER STATIONS IN ELECTRIC POWER SYSTEMS. Proceedings Series. Proceedings of the Symposium Held in Vienna, 5-9 October 1970. (International Atomic Energy Agency, Vienna (Austria)). Mar 1971. 749p. (In several languages). (CONF-701031). IAEA $20.00.

Information on the use of nuclear power plants in integrated power systems is presented under the following broad topics: specific features of nuclear power plants relevant to their economic integration in electric power systems; general planning problems arising from the introduction of nuclear stations in electric power systems; application of analytical and simulation methods to the planning and operation of electrical systems with nuclear components; prospects for the economic integration of nuclear power plants in national power systems; and impact of international, regional, and inter-industrial cooperation on the economic integration of nuclear power plants. Separate abstracts are included for 47 of the 48 papers presented. One paper has previously appeared in NSA and can be found in the Report Number Index under TRG-Report-2090. (D.C.C.)

For abstracts of individual papers see: 34206-34209, 34234-34267, 34332, 34376, 34381, 34387, 34388, and 34397-34400.

34230 (TID-25703) GUNDREMMINGEN NUCLEAR POWER PLANT MONTHLY REPORT, FEBRUARY 1971. (Kernkraftwerk RWE-Bayernwerk G.m.b.H., Gundremmingen (West Germany)). 23 Mar 1971. 48p. (In German). Dep. NTIS.

The plant was operated continuously at full load. The changing of the control-rod withdrawal sequence gave rise to a slight increase in the activity of the reactor water and waste gas. When the repaired starting transformer was taken into service again, there was an interruption of the station-service supply which resulted in the secondary steam being shut off. For about one hour the power plant operated at 80 MW. The transport of irradiated fuel elements to Mol and of radioactive wastes to ASSE was continued. Conversion of the entrance to the controlled area is making rapid progress. (auth)

34231 (TID-25704) SENA NUCLEAR POWER PLANT ANNUAL REPORT FOR 1969. (Societe d'Energie Nucleaire Franco-Belge des Ardennes, Chooz-lez-Givet (France)). 15 Sep 1970. 18p. Dep. NTIS.

At the SENA nuclear power plant, 1969 was taken up mainly by repairs to the reactor internals, in which serious damage had been found at the beginning of 1968. At the end of the year, when all the repairs were completed, a series of static and dynamic tests were performed to verify the hypothesis taken as the basis for the repairs and to check their quality. Numerous adjustments were made throughout the year to most of the power plant equipment. These were checked by a brief period of operation at low power during tests on the reactor. It is expected that normal service of the plant will be resumed in the first quarter of 1970, without a change of characteristics. (auth)

34232 (WAPD-MRP-134) PRESSURIZED WATER REACTOR (PWR) PROJECT. Technical Progress Report, July 25-October 23, 1970. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Contract AT(11-1)-Gen-14. 18p. Dep. NTIS.

Plant operations and testing on three and four reactor coolant loops continued satisfactorily during this period and the total operating time with PWR-2 Seed 2 was increased to 4083 equivalent full power hours (EFPH). The reactor plant was operated at full power (150 MW(e)) at about 3600 EFPH for the second time during Seed 2 lifetime to demonstrate full power capability. Measured coolant flows in the diagonal seed fuel assemblies have decreased by 5% during the first fourteen months of power operation, with no net decrease in the last three month period. Measured coolant flows at all core locations are in excess of design values and thus core thermal capability remains adequate. A program to isotopically examine an irradiated PWR-2 Seed 1 seed fuel subassembly and a blanket fuel subassembly has been defined. A review of two loop operation established that the power limit for this mode of operation could be increased from 37% to 45% of full reactor power. (auth)

34233 NUCLEAR ENERGY IN 1970. Negrini, R. Energ. Nucl. (Milan); 18: 221-7(Apr 1971). (In Italian).

A review is given of the past year's main events and activities relevant to the nuclear power field — including the fuel cycle in its various aspects. A short account on reactor research and development is included. (auth)

34234 OPERATING REQUIREMENTS FOR NUCLEAR PLANT IN THE UNITED KINGDOM AND THEIR EFFECTS ON STATION DESIGN. Ashmole, P. H.; Gregory, A. R. (Central Electricity Generating Board, London). pp 3-17 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Because of its low-energy production cost and limited capacity, the role of nuclear plant has been, so far, that of supplying the base system load. In that role it is not called upon to supply any of the variable components of system load, the regulating duty falling entirely on conventional or other plants. While the conventional plant is also eligible for base-load duty in its early years of service the relevant design characteristics of the plant do enable it to participate when required in a regulating duty. The economic status of nuclear plant merits the incorporation of an increasing proportion in future power systems and in the C.E.G.B. system it is expected to approach closely the base system load by the later 1970s. Thus it is appropriate to consider the characteristics required of the future plants to enable them to participate in the regulating duty or, alternatively, to consider how this regulation could be achieved by supplementary external regulating means should these be more economic. The nature of system load variations and the plant characteristics required to deal with them are described. The implications of restricted flexibility of nuclear plants are discussed. It is shown that the nuclear operating flexibility requirements on a system comprising mainly fossil-fired plants are more onerous than for a system which can rely on hydro plant or external transmission connections to adjacent power authorities for its regulating requirements. The effects of system requirements on station design are explained. The flexibility of nuclear plants now operating or under construction is less than fossil-fired plants but the possibilities of making minor modifications to the plant and to their fuel so that they may play their role more effectively are being studied. Much attention is being paid to the design of stations now being ordered to ensure they shall be capable of satisfying system operating requirements. Another aspect of design receiving attention is the method of refueling. The Mk. I (Magnox) reactors now operating are refuelled on-load. This was considered essential in view of the large number of individual, low burnup fuel elements and the desire to maintain high load factors. Although the economic incentive to refuel Mk. II (AGR) reactors on-load is less, it is still substantial and so on-load refuelling has also been adopted for these reactors. The question as to whether Mk. III (HTR) reactors should be refuelled on- or off-load is being examined in terms of both the technical and economic aspects. (auth)

34235 PROBLEMS OF OPERATING NUCLEAR POWER STATIONS. Metteil, A. (Electricite de France, Paris). pp 19-41 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The experience which Electricité de France has acquired in the operation of nuclear power stations relates mainly to graphite-gas reactors. The problems of operating graphite-gas reactors are a direct consequence of the following two basic characteristics of existing or projected plants: the high unit capacities, which make good operating reliability essential; and the low marginal cost, which implies operation in the lower part of the load diagram so that flexibility is not an immediate requirement. Refueling, which is usually performed without a shutdown, is a fairly onerous task. The maintenance of the nuclear equipment involves costs comparable to those for conventional installations and poses no special problems except that the personnel must be medically fit to work under radiation conditions and that it is difficult to return contaminated components to the manufacturers. The problem of accidents is examined by considering three examples: repairing the CHINON 1 reactor in the case of a breakdown; vibration of the CHINON 3 heat-exchangers; melting of fuel elements in a channel of St. LAURENT 1. These illustrations indicate the problems encountered in the present installations due to the difficulty of taking appropriate action in radioactive surroundings, the prototype

nature of the installations and the inadequacy of some of the safety devices. The consequences as regards availability and cost of repair are serious, but once these problems have been solved the operation of nuclear power plants will present the user with no major problems. (auth)

34236 FLEXIBILITY OF NUCLEAR POWER PLANTS FOR PEAKING PURPOSES IN ELECTRIC SYSTEMS. Levai, A.; Bueki, G. (Technical Univ., Budapest). pp 95-103 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

It is generally agreed that the variable load and peaking requirements will present an increasingly severe problem with the introduction of nuclear power plants into interconnected systems. Some suitable developments in nuclear power plants which render economical operation with variable loads are described. Three load-following processes were investigated: overloading of the plant at the expense of efficiency by the disconnection of high-pressure preheaters for water-cooled and gas-cooled nuclear power plants; the electric peaking possibilities available in the dual-purpose plant for heat and electricity; and the characteristic flexibility of nuclear power plants with respect to rapid load following. 7 references. (auth)

34237 PROBLEMS OF NUCLEAR STEAM-POWER PLANTS FOR INDUSTRIAL PURPOSES. Mayer, G. (Fichtner Consulting Engineers, Stuttgart). pp 115-22 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The problems of nuclear steam power plants for industrial purposes are discussed. An economic comparison shows that gas-fired plants and nuclear plants are keenly competitive. As gas-fired plants are capable of providing reserve capacity without much additional capital outlay, nuclear power plants may be less economic. When several small plants are built simultaneously, the plant costs can be of the same order of magnitude as the costs for a large plant. (auth)

34238 SGHWR TECHNICAL STATUS AND OPERATING EXPERIENCE. Gabriel, E. (Nuclear Power Group Ltd., Knutsford, Eng.); Smith, D. pp 175-203 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The SGHWR combines established direct cycle and pressure-tube technology with the advantages of moderation by heavy water at atmospheric pressure. A 100-MW(e) SGHWR power station was constructed by the UKAEA in conjunction with British industry at Winfrith Atomic Energy Establishment. Construction of this plant began in mid-1963 and it first reached full power in January 1968. It has now supplied power to the CEGB for almost three years and demonstrated the viability of this type of reactor. The constructional sequence for the SGHWR is described. The particular features of the SGHWR concept which facilitate construction are discussed. Particular emphasis has been given in the operation of the Winfrith SGHWR to an analysis of the factors affecting reliability and availability. The availability record is analyzed in detail and is used to draw general lessons affecting the design and operation of nuclear power stations. The SGHWR has an off-load refueling machine and in addition a partially complete on-load machine. Although the on-load machine is not operational certain lessons have become apparent concerning the relative merits and applicability of off-load and on-load refueling concepts. One of the key factors affecting reliability is the accessibility of plant for inspection and maintenance. Two particularly significant operations are described which illustrate this point. These are concerned with the removal and replacement of pressure tubes and a chemical cleaning of the primary water circuit. The dynamic characteristics of the SGHWR are described together with results of the experimental control and dynamics program. Those features of the SGHWR which affect its integration into major grid systems are discussed. 7 references. (auth)

34239 PROBLEM OF COVERING THE MODULATED PART OF THE LOAD DIAGRAM IN LARGE POWER SYSTEMS IN THE CASE OF LARGE-SCALE COMMISSIONING OF NUCLEAR POWER STATIONS. Beschinskii, A. A.; Kislov, K. P.; Khainsov, Ya. I. (Inst. of Atomic Energy Energy, Moscow). pp 207-18 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

A short analysis is presented of the main trends in the development of the fuel-power balance. It is shown that atomic energy is playing a valuable role in the fuel balance, especially in the case of electric power generation. The basic principles of the methodology governing selection of the optimal structure for generating capacities in continuously developing power systems are discussed with special emphasis on the relation between nuclear stations and other power generation facilities, including peaking stations. The problems related to the large-scale construction of nuclear power stations are described. The scientific and technical problems which are being tackled in the Soviet Union in connection with the transition to the large-scale use of atomic power stations in electric power generation are analyzed. (auth)

34240 PLANNING PROBLEMS CONNECTED WITH NUCLEAR POWER INTEGRATION IN THE FEDERAL REPUBLIC OF GERMANY. Huenlich, W. H. F. (Vereinigung Deutsche Elektrizitaetswerke, Frankfurt am Main). pp 231-54 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

On the basis of the actual situation of the electricity supply industry in the Federal Republic of Germany, the competition between the different energy sources and their influence on the nuclear power integration in the country is analyzed. Particular attention is paid to the main competitors of nuclear energy, namely fuel oil and natural gas. The functions and structure of the existing extra high voltage and high voltage systems are described followed by a discussion of the problem as to whether the integration of nuclear power stations may lead to a mainly centralized or decentralized power generation. Major planning problems closely linked to this problem are being considered such as the increase in demand, the choice of site, the cooling-water situation, the change to larger turbine-generator units, and the impact of these criteria on the future power system development. 8 references. (auth)

34241 COMPARATIVE ECONOMIC EFFICIENCY OF NUCLEAR POWER STATIONS WHEN OPERATING IN INTEGRATED POWER SYSTEMS. Bakanov, A. V.; Koryakin, Yu. I. (Inst. of Atomic Energy, Moscow). pp 255-64 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The variations in the economic indices of nuclear power stations are analyzed for the operational and handling requirements that have to be met by these stations when operating in integrated power systems. The data on the comparative economic efficiency of nuclear stations when operating in conjunction with other types of power stations are discussed. The dependence of the operating characteristics of nuclear stations on the intended purpose of the reactor, on the structure of capital investment and power production costs, and on the manner in which the rated capacity is utilized is described. In this connection, requirements are formulated for the operating and technical characteristics of nuclear power stations in the light of transport conditions and type of electric power consumption. (auth)

34242 PROBLEMS ENCOUNTERED IN THE INTRODUCTION OF A NUCLEAR POWER PROGRAM IN A DEVELOPING COUNTRY. Aybers, N. (Technical Univ., Istanbul). pp 265-79 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The sharp decreases in unit investment costs of nuclear plants with increasing size and the difficulties encountered on integrating a large nuclear power station into the relatively small grids of developing countries are described. The growing tendency of many of the developing countries towards independence in the peaceful nuclear field and the serious shortage of capital in these countries are somewhat paradoxical and present many problems. Special problems faced by a developing country about to install its first nuclear power reactor are discussed. Integration of a

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nuclear power development in the general policy of the utilization of energy sources and the numerous factors involved in the decision to have recourse to nuclear power are examined. Particular attention is paid to optimal size selection, choice of reactor type and policy with regard to nuclear fuel supplied. Several possibilities by which a developing country can procure its fuel are discussed. It is shown that the introduction of a well-planned long-term economically viable nuclear power program into a developing country is a difficult task which can be accomplished only through effective organization. 4 references. (auth)

34243 JOSE CABRERA NUCLEAR POWER STATION. Pascual, F. (Junta de Energia Nuclear, Madrid); Lopez Rodriguez, M.; Guitart, J. L.; Gimenez Ramos, G. pp 281-98 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Spanish).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The José Cabrera Nuclear Power Station is equipped with a pressurized-water reactor and has a net electric power output of 153 MW. The reactor went critical on 30 June 1968 and the station was first connected to the grid on 14 July 1968; testing has been completed and the plant is now operating at full power. The studies leading up to the decision to construct the José Cabrera Nuclear Power Station and the problems that arose during construction are reviewed. An account is also given of the commissioning tests and of the experience gained, especially with regard to safety and station availability. A summary is given of the studies carried out in connection with the site of the power station and its characteristics. Consideration is being given to the possibility of constructing a second unit at the same site to supply power for the Tagus–Segura river link-up; the simultaneous construction of a pumped-storage hydroelectric station to cover peak periods will ensure optimum utilization of the nuclear power station. As this is the first Spanish nuclear power station, the studies made with a view to ensuring maximum Spanish participation in the preparation of specifications, the provision of equipment, the actual construction work and the commissioning and operation of the power station are described. (auth)

34244 ECONOMIC ANALYSIS OF CHINSHAN NUCLEAR UNIT NO. 2 IN TAIWAN BY TAIWAN POWER COMPANY. Pan, P. S. (Taiwan Power Co., Taipei). pp 313-35 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Primary energy resources in Taiwan are not sufficient to supply the present as well as the conceivable future demands. As the sole agent to generate and distribute electric power in Taiwan, the Taiwan Power Company has deliberated a comprehensive power system expansion program in which two identical nuclear units are integrated. The economic appraisal that supports the above decision is presented. A brief review of the economic assessment of the Chinshan No. 1 636-MW(e) (gross) BWR unit is included. The up-dated appraisal of an identical No. 2 unit is described. The investment for Chinshan Unit No. 1 is estimated to be US $166,642,000, including the pre-investment for land and common facilities for multi-unit installation and spare parts. The real cost allocable to the Unit No. 1 is to be US $154,530,000 and that to Unit No. 2 US $134,530,000, both evaluated on a simultaneous construction basis. Meanwhile, the project cost for the alternative oil-fired 600-MW unit is estimated at US $76,800,000. The nuclear fuel costs are computed to be US ¢ 14.03 and 16.61 per million Btu for Unit No. 2 without and with escalation respectively, while present fuel oil cost is US ¢ 41.57 per million Btu. The production cost computed on project basis shows that the nuclear power is economically competitive with the conventional thermal, even with fuel price escalation, and that sequential construction of Unit No. 2 with Unit No. 1 is preferable. Three alternative thermal development programs, with the same addition of units but different in the completion date of Chinshan Unit No. 2, are contemplated for investigation. The capital investment and annual expenditures discounted to 1970 present worth by 8.5% p.a. interest rate show that early implementation of Chinshan No. 2 is economically favorable. The cashflow of the nuclear program against that of the conventional thermal program is appraised to assess the rate of return on the additional investment imposed by the nuclear program. The study made in accordance with the IBRD practice of "discounted cash-flow method" results in a rate of return of 9.73%. The three different approaches presented all demonstrate the economic advantage of early implementation of the Chinshan Nuclear Unit No. 2 and affirm the philosophy of twin unit economy in the nuclear power development in Taiwan. (auth)

34245 ECONOMIC PROBLEMS OF THE UNIT SIZE INCREASE OF ELECTRIC POWER PLANTS IN THE LARGE ELECTRIC POWER SYSTEMS OF THE USSR. Borodyanskii, E. Z.; Vol'kenau, I. M.; Zeiliger, A. N. (Inst. Power Engineering, Moscow). pp 337-49 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The problems associated with increases in the unit size of power plants and electric power stations are analyzed with special reference to the development of electricity supply systems in the Soviet Union. After a brief historical review of the development of power systems and of the increases in unit size during the period 1920–1970, the prerequisites for further unit size increases are described. The economics of increasing unit size are considered and the principal factors governing the trend towards larger power units are set forth and analyzed. The impact of this trend on the development of power systems—especially on reliability, reserve levels, the extent, voltage and configuration of grids, and shot-circuit currents—is discussed. Special considerations associated with integration of large nuclear power stations are also examined. The basic technical and economic problems encountered in connection with unit size increases are stated and methodological principles given for determining optimum size with allowance for the system load factor. (auth)

34246 COMPETITIVENESS AND INTEGRATION OF NUCLEAR POWER PLANTS IN SYSTEMS THAT ARE MOSTLY HYDRO-ELECTRIC. Cintra do Prado, L. (Comissao Nacional de Energia Nuclear, Sao Paulo, Brazil). pp 351-60 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Competitiveness is a major, but not exclusive, criterion in the adoption of nuclear power plants for expanding electric systems. When hydro units are a large component of a given system, some of them, in order to be able to satisfy the peak generation load, have capacities somewhat higher than the "firm power" implied by hydrological conditions in the region and by existing pondage and storage reservoirs. As a consequence, such plants operate at medium or low values of the annual utilization factor. Nuclear power stations can be and, for economic reasons, ought to be operated with high utilization factors. Utilizing dimensionless quantities, as in the theory of models and physical similarity, a simplified procedure to evaluate competitiveness between possible additions to an electric system is presented. The procedure is based on the share corresponding to the spent fuel in the breakdown of generating costs, and takes into account actual values assigned to the utilization factors for hydro, conventional or nuclear stations. The method permits an expedient assessment of different combinations of further plants. More accurate solutions have to be sought by ordinary methods which include other data besides competitiveness. 9 references. (auth)

34247 ASSESSMENT OF THE MERIT OF MEETING THE RAND BASE-LOAD FROM A LARGE NUCLEAR COASTAL INSTALLATION. Maunders, E. J. (National Nuclear Research Centre, Pelindaba, S. Afr.). pp 361-75 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

From the point of view of the geographical distribution of electrical load centers, South Africa is quite unlike most parts of northern Europe. The country's generating capacity at present is roughly 8000 MW, but some 80% of this is concentrated in one area. This is the area where most of the gold mines and other mineral workings are to be found, and it also happens to be the only region in the country with significant coal deposits. However, this is a region which is frequently troubled by water shortages and, to add to the problem, it is some 300 miles distant from the sea. It is clear, therefore, that future power generating plant in this area will have to incorporate expensive dry-cooling towers. An alternative would be the establishment of a "nuclear park" on the coast, close to one of the other load centers, with a 700-kV transmission line serving both load centers. An earlier preliminary study showed that a large, light-water-cooled reactor would probably be competitive with the coal-fired

units at the inland load center in the late 1980s, but the wisdom of installing either type of generating equipment must be questioned with water such a valuable commodity in this area. The results of a preliminary study comparing the cost of electricity derived from individual inland fossil-fired plants with that of electricity from a multiple coastal nuclear installation and its associated transmission line are presented. If the coastal installation is planned, not as a series of individual power station units, but as a number of reactors sharing a building, a biological shield, and as much peripheral equipment as possible, it can be shown that the savings which might be realized apparently offset the cost of the transmission line between the inland load center and the coast. Another consideration, but one that is not easy to attach a value to, is the fact that the inland water thus saved would then be available for other uses. 13 references. (auth)

34248 ELECTRICITY COST IN AN IDEALIZED PRODUCTION SYSTEM. Pelser, J. (Reactor Centrum Nederland, Petten). pp 379-96 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The price per kWh is represented by the sum of a fixed cost and an operating cost. The fixed cost is usually found from the capital investment, the interest rate, amortization period, and the annual utilization factor. Hence, the fixed part of the kWh cost is not determined by the capital investment, the interest rate, and the kWhs produced during the economic life of the plant, but merely by the system of financing. It is suggested that the energy production of each generating station during its lifetime can be predicted and from this prediction the fixed cost be calculated. This is done on a model representing an idealized production system consisting of many individual stations. Calculated are the cost per individual station and the average cost for the whole system. A system of conventional stations alone and a system of conventional and nuclear stations are compared. It is shown that the introduction of nuclear stations lowers the average cost but at the same time increases the fixed part of the kWh cost, borne by any conventional stations subsequently built. (auth)

34249 SYSTEMS ANALYSIS IN THE DEVELOPMENT OF TECHNICAL POLICY FOR NUCLEAR POWER PROGRAMS. Bainbridge, G. R.; Farmer, A. A. (United Kingdom Atomic Energy Authority, Risley, Eng.). pp 419-34 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The advent of nuclear power for electricity generation has enabled many utilities to improve the "mix" of their power station types, primarily with the addition of relatively large reactor/turbine units suitable for base-load operation. Whether new nuclear, fossil, hydro or other types of plant are most economic for introduction at a particular time will depend on the duty they are required to perform and the improvement they can effect in perhaps a changing role throughout an operating lifetime in the utility's service. From the economic viewpoint this requires an assessment of the reduction in the average generating cost of the plant, old and new, in the utility's system that each of the alternatives can give when introduced as part of an integrated program. Such analyses have been carried out for several national electricity grid systems using techniques based on the "Discount" computer program. Some aspects of the results obtained for the British grid system by the UK Atomic Energy Authority are illustrated. These have been of considerable importance in assisting the formation of technical policies concerning the design characteristics most suitable for future nuclear power stations, the appropriate timing for their development, construction and large-scale commercial operation and the required fuel production and associated service industry. (auth)

34250 OPTIMIZATION RESEARCH ON THE ECONOMIC INTEGRATION OF NUCLEAR POWER STATIONS IN ELECTRIC POWER SYSTEMS. Frankowski, W. (Inst. of Nuclear Research, Swierk, Poland). pp 435-44 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Extensive research has been carried out on the economic optimization of developing systems of nuclear power plants. The optimum distribution of the installed power between particular types of nuclear power plants was investigated. This was analyzed both as an "internal problem" of nuclear energy (when only the nuclear component of the power generating capacity is taken into account) and in its final shape, when the whole power generating system, including its conventional part, is concerned. Forecasts for which reliable data can be found on the growth of electrical power demand, as well as on the economic and technical parameters, are not much longer than the life of a particular power station. On the other hand, it is shown that the result of an optimization analysis of the problem strongly depends on the length of the forecast. There is a "range of economically favorable solutions" rather than a unique optimum program. This is often overlooked and the results of optimization analysis are interpreted too literally. This range of uncertainty can be optimistically interpreted as a range of freedom in selecting nuclear power development programs, the more so since the cumulative expenditures for particular programs in the range of economically favorable solutions differ very little. Although the economic criterion is always used in the calculations as the final one, the very strong impacts of such factors as the fuel cycle and existing power installed in conventional power plants are analyzed. These form a set of constraints to be met when the minimum of the above criterion is being found. Even in this case, there is still a similar range of freedom in selecting nuclear power development programs. This seems to be quite favorable from the point of view of economic integration of nuclear power stations in electric power systems. 7 references. (auth)

34251 STUDY OF THE PROBLEMS RAISED BY INTRODUCING INTO AN ELECTRIC POWER SYSTEM A NUCLEAR REACTOR OF LARGE CAPACITY RELATIVE TO THAT OF THE SYSTEM. Larivaille, Pierrette (Electricite de France, Paris). pp 445-65 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The economics of scale associated with capital investment in nuclear plant are very substantial; moreover, the proportional costs of nuclear power plants are usually lower than those of conventional thermal plants. This might be taken as a reason for installing large nuclear units once they become competitive. However, the introduction of a large nuclear power plant into a small system raises a number of problems: in such a system, where the annual increase in demand is (in absolute terms) rather small, investment in nuclear plants may result in fairly long periods of capital underutilization. Moreover, the introduction of large units jeopardizes the reliability of the power supply. It is therefore necessary to look for a compromise. Is it preferable to invest immediately in a smaller unit or to wait until the system has grown to the point where a larger unit can be adopted? Economic analysis should relate not only to immediate decisions but also to those which will have to be taken in the more distant future. The problem is therefore one of defining a strategy or a set of decisions that will determine each year, over a long period, the capital investment to be undertaken and the plant operating schedule to be adopted; by defining the optimum strategy one determines the optimum data for entry into service of the first nuclear power plant and its size. This is a classical problem of capital investment in the electricity generating industry. It is a complex problem and there is no general method applicable without modification to all electric power systems. A simplified model that takes into account the sequential character of the decisions without complex formalization or difficulties of resolution is presented. 18 references. (auth)

34252 INTEGRATION OF A POWER REACTOR IN THE TURKISH INTERCONNECTED SYSTEM. Wolfensberger, H. (Suiselectra, Basel); Do Dai, D.; Do; Sahin, S. pp 467-91 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The rapid load increase and power demand in Turkey as well as a very extended interconnected system with long transmission lines called for a load analysis of this system, especially in view of the proposed erection of a nuclear power plant of 300 MW to 400 MW capacity. The load flow analysis helps to evaluate the optimum size of the unit as well as the ultimate capacity of the plant. It is also helpful for the determination of the site, of which seven different ones had to be investigated. The stability study shows the possibilities of an interconnected system to restore a perturbed balance of load and power after a fault on a transmis-

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sion line or a breakdown of a power station. For both the load flow analysis and the stability study, an IBM 1130 digital computer was used. It is shown, by examining the years 1977 and 1982, that the reactive power requirements can be met by the use of shunt and series capacitors and shunt reactors and that some of the reactive power must be supplied by generation. Some of the long 380-kV transmission lines have to be 50% series-compensated. The power gap in 1977 of some 400 MW can be met by a nuclear power station running on base-load program. Heavy, light load and fault conditions were examined and showed the necessity to adapt the proposed extension plan of the interconnected system. For the stability study, the interconnected system load had to be reduced to a maximum number of 12 generators and 40 buses. The results are therefore only an approximation. The site of the power reactor for all cases examined is assumed to be near the load center of Istanbul. The system compensation provided as a result of the load flow analysis shows that it is sufficient to prevent the falling out of step of the generators. (auth)

34253 COMPUTER PROGRAMS TO DETERMINE THE CONTRIBUTION OF NUCLEAR ENERGY TO ELECTRIC POWER PRODUCTION. de Boer, A. A.; Leclercq, J. C.; de Haan, W. (Commission of the European Communities, Brussels). pp 493-519 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The CNEN, Aachen, and Interatom programs are discussed, special attention being given to their ability to take into account the criteria for the most efficient operation. The choice of meaningful power plant parameters is often impeded by: the lack of thorough information, mainly on the advanced reactor types; the shortcoming and uncertainty of many important data; and the low comparability (and mainly the uneven credibility) of the data for various types. Some difficulties also appear in the choice of such economic parameters as interest rate, escalation factor, and actualization (present worth) rate. Relying upon the results of previously indicated methods, some tentative conclusions are presented upon: the most important parameters, i.e. the data having the greatest influence on the results; the general behavior of installation curves; the limitations of minimum cost criteria and the relevance of other criteria; the positive feedback effects (for instance the learning effect); and the negative feed-back effects (for instance the competition from oil). (auth)

34254 COMPUTER SIMULATION FOR EVALUATING NUCLEAR POWER STATIONS IN A NATIONAL ELECTRICAL POWER ECONOMY. Deonigi, D. E. (Battelle-Northwest, Richland, Washington). pp 521-34 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

To properly plan the utilization of energy resources, a computer simulation of the US power economy was developed which is capable both of evaluating the role of nuclear power and fossil power and of determining the proper course for developing reactor systems that could improve resource utilization. This simulation is based on linear programming techniques and is readily adaptable to represent any geographic region or set of national constraints. This model includes the effects of uranium price increases caused by the depletion of low-cost uranium reserves. It also includes the capability for importing and exporting nuclear materials (^{235}U, Pu, ^{233}U). The results from this model not only describe the percentage of nuclear capacity installed in each of 48 power-supply areas within the contiguous US, but also quantify the possible benefits from developing a particular reactor system such as the LMFBR. The simulation of the national power economy is in effect a simulation of the franchised utility system. Thus, incorporated in this model are the effects of system load factors and the decision-making process for new power stations. The model chooses the optimum application for plutonium produced. This optimum application frequently includes stock-piling for use at a time when the plutonium value is considerably higher because of the availability of an advanced reactor type. Each reactor type represented in the simulation can be made available at different loads and with a variety of alternative fuelling strategies that include fuel exposure and plutonium recycle. Thus, the results for a particular reactor type indicate the degree to which a reactor type may expect success in the marketplace and the load factor at which the power station may operate throughout its life, and the type of fuel it may use. Some specific results of calculations for fossil-fuel power stations and for LWRs, advanced converters and breeder reactor systems are presented. (auth)

34255 PLANNING OF NUCLEAR POWER PLANT. Eibenschutz, J. (Comision Federal de Electricidad, Mexico City). pp 535-45 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Spanish).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Studies to assess the desirability of installing nuclear power stations in Mexico were started in 1966, taking the form of simplified analyses of power production costs. Later, with the collaboration of the Stanford Research Institute, a model was developed for simulating the expansion of an electric power system, and on the basis of the results obtained it was decided that the introduction of nuclear power plants into Mexico's central power network was, in fact, desirable. Because of the widely differing prices quoted for nuclear power plants, it was decided to invite bids with a view to establishing whether the time was ripe for the construction of the first nuclear plant. In addition, models were used in studying the relationship between the energy sector and the national economy and that between nuclear power projects and the energy sector. (auth)

34256 EFFECT OF THE INTRODUCTION OF NUCLEAR POWER PLANTS ON THE OPERATION AND PLANNING OF AN ELECTRICITY SUPPLY SYSTEM. Arabeyre, M. L.; Guillaumin, P.; Noe, C.; Pouget, J. (Electricite de France, Paris). pp 547-56 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

An operations research model, GRETA, which simulates the optimum management of a power plant risk by minimizing the mathematical expectation of the annual operating costs (essentially fuel costs), is described. The model takes into account changes in hydraulic conditions, thermal availability (simulated by a MARKOV circuit) and consumption (with correlations between the demands during various weeks). The power plant mix may include hydroelectric power stations, conventional thermal plants, nuclear plants of specified size and peaking facilities (pumped-storage plants or gas turbines). The effects due to the presence of nuclear power plants fall into two categories: the operating pattern changes (the use made of the other types of plant is affected); the optimum plant mix changes (especially if the nuclear component includes large plants), it being necessary to have more peaking facilities so as to ensure the same reliability of supply. (auth)

34257 STUDY OF THE OPTIMUM ELECTRIC POWER PLANT MIX IN THE WESTERN PART OF YUGOSLAVIA. Pozar, H. (Univ., Zagreb); Udovicic, B. pp 557-74 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The use of linear programming to determine the optimum electric power plant mix is described. By dividing consumption into a constant part and a variable part, it is possible to take into account both the necessary power and the necessary energy. Since it is not possible to determine in advance either the specific cost of fuel, or the operating life of thermal power stations, or the critical period of the system since all these depend on the electric power plant mix, which must be determined first, one arrives at a rapidly converging iterative process. (auth)

34258 OPTIMUM TYPES, SIZES, AND SITING OF HYDROELECTRIC AND THERMAL POWER STATIONS FROM THE STAND-POINT OF POWER TRANSMISSION. Deledicq, A.; Thiriet, L. (Commissariat a l'Energie Atomique, Paris). pp 575-81 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The adoption of electricity production methods in a large geographic region involves the problem of choosing between different power station types, sizes and sites. The transmission of the power raises questions both of capital investment (the construc-

tion of nuclear power stations and the establishment of transmission networks) and of transmission line losses. How this complex of problems can be handled by means of a method based on dynamic programming and the concept of k optimality is described. (auth)

34259 NUCLEAR POWER STATIONS BECOME AN INTEGRAL PART OF THE ITALIAN ELECTRIC POWER SYSTEM. Angelini, A. M. (Ente Nazionale per l'Energia Elettrica, Rome). pp 585-95 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The contribution of the various primary sources, and particularly nuclear energy, is reviewed in the light of Italy's future power requirement. The integration of nuclear power stations into the Italian electric power system is considered from the following standpoints: (1) evolution of reactor system, and prospects for their use in the Italian network; (2) interdependence of construction plans for conventional stations, hydroelectric stations (mainly for regulation purposes), and nuclear stations; (3) local problems associated with nuclear plant siting; and (4) nuclear fuel supply. (auth)

34260 SPANISH NUCLEAR POWER PROGRAM: INTEGRATION OF NUCLEAR POWER PLANTS INTO THE ELECTRICITY SUPPLY SYSTEM. Gaitan, I. (Ministerio de Industria, Madrid); Ortega, J.; Palacios, L.; Pascual, F. pp 597-611 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Spanish).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The National Electricity Plan, which has been approved by the Government and is based on a study aimed at optimizing the Spanish electricity supply system, provides for 8.5 million kW of nuclear power by 31 December 1981, representing 21.8% of the total installed capacity. Forecasts of Spain's power resources in the period following the Plan indicate a total nuclear capacity of 71 million kW by the end of this century, representing 60.7% of the total installed capacity. Studies show that even in the first stages the unit size of nuclear plants will be of the order of 800–850 MW(e). As regards the types of reactors to be installed, it is expected that most will be light-water reactors and that fast breeders will be incorporated into the system during the period 1980–90, once they have been commercialized and sufficient plutonium becomes available. A study has been made of Spain's present and future fuel resources and of the need to develop to a maximum the industries associated with all parts of the fuel cycle. The effect of nuclear power plant construction on the Spanish capital goods industry, for which it will provide markets and constitute an essential factor in the development of new technologies that can help to raise manufacturing standards considerably, is considered. (auth)

34261 INTEGRATION OF NUCLEAR POWER PLANTS IN POLISH ELECTRIC POWER SYSTEM. Fiszer, W. (Ministry of Mining and Power, Warsaw); Kizewski, P.; Skopec, Z. pp 613-18 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The rapid industrialization of Poland has greatly increased the demand for heat and electricity. Although Poland is rich in natural resources of hard coal and brown coal, attention must be turned to the development of nuclear power plants to relieve the country's economy of the additional mining investments. On the assumption that the first nuclear plant is commissioned by 1980, the reactor's output imposed by the grid will be about 1000 MW(e) (with one or two turbosets). The location of the coal resources and the direction of the expected power flow indicate that the northern part of the country is best suited for the first nuclear plant. After 1975 the 500-MW(e) units will be integrated in the 400-kV grid. It is assumed that the first nuclear plants will not require a higher system voltage. (auth)

34262 PROSPECT OF NUCLEAR POWER PLANT IN IRAN. Afshar-Bakeshloo, A. (Tehran University Nuclear Centre). pp 619-39 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The electrical utility in Iran is under the Government. The country is divided into 10 electrical zones, each supplied by several units. At the end of 1969 the total installed capacity was 1313 MW(e). Details of the forecast future power demand and type of units for all the zones for 20 years (up to 1987) are presented. Net generation is expected to be 9574 MW(e) in 1987. This figure reflects the development of industry according to Government plans. The estimated specifications for the required stations are included. Figures are given for the energy exchange between the electrical zones. Also, price information on oil and coal is presented. The existing percentages of total capacity in hydroelectric (35%), steam (33%), diesel (22%) and natural gas (10%) power stations will be by 1987 respectively 68%, 25%, nil and 7%. Recently, the Government has been interested in studying the economic feasibility of nuclear power for the future in Iran. Some very preliminary estimates of the probable size of a nuclear power plant are given. It is concluded that a unit of 500 MW(e) nuclear power would be desirable in 1980 for an area that is far away from the fuel resources and also close to the industrial load center. (auth)

34263 ASSESSMENT OF THE INFLUENCE OF CERTAIN FACTORS ON PLANS FOR CONSTRUCTING NUCLEAR POWER STATIONS AND INTEGRATING THEM INTO THE ELECTRIC POWER SYSTEM OF THE CZECHOSLOVAK SOCIALIST REPUBLIC. Novak, S. (Power Research Trust, Prague). pp 641-57 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Presented are the basic features of the computation program, the input data, and an outline of the actual calculations for a balanced development of nuclear power stations in Czechoslovakia. The effect of uncertainties associated with some of the input data on the results of the calculations is assessed and limitations on the development of the various power reactor types used in the computation program are considered. The results of the calculations relating to a number of power reactor types belonging to the initial period of development include the technological and economic parameters of the electric power system, and especially of the nuclear power stations. The technological parameters (annual and total uranium consumption, quantity of uranium, contribution of different power reactor types to the total electrical output of the system, annual generation schedule, etc.) are determined for a period of 50 years. The economic parameters (discounted annual expenditures, total annual expenditures within the system, unit cost of electric power generated, etc.) are determined for a period of 20 years. Various problems arising out of the operation of the proposed power reactor types in conjunction with conventional power stations are discussed. (auth)

34264 NEED FOR NUCLEAR POWER IN THAILAND. Pochanart, T. (Electricity Generating Authority, Nonthaburi, Thailand). pp 659-67 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The Electricity Generating Authority of Thailand is responsible for power generation and transmission in the country. The sources of generation consist mainly of hydro and thermal plants, which supply most of the energy, and the rest are gas turbines and diesel plants for peaking and reserve. The average annual increase of energy has been sustained at approximately 30% for the past several years. In the light of such an increase in load growth, the Authority has accelerated the installation of appropriate generating plants to meet the heavy demands. The Authority's plan to increase the generating capacity has been adopted in a long-range development program covering 1970–1980. This program includes the installation of a nuclear power plant of 500 MW(e) which is scheduled to supply bulk energy required in 1979. There are several conditions that favor the use of nuclear energy rather than other sources of energy in the country, namely: the scarcity of economical hydro resources; the limited source of fuel supply; and the high rate of growth in demand. Interest in applying nuclear energy for power in Thailand began several years ago which is evidenced by the Authority's recently completed feasibility study of nuclear power generation. Preliminary preparation work has already begun at the site selected on the east coast of Thailand. Further study for the optimum type of nuclear

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plant has been carried out to ascertain that the type of plant selected has been proven through actual commercial operation with minimum operating problems. (auth)

34265 PARTNERSHIP COMPANIES: A METHOD OF INTEGRATING LARGE NUCLEAR POWER PLANTS INTO INTERCONNECTED SYSTEMS. Pouly, J. (SA d'Enterprises Electriques, Baden, Switzerland). pp 671-81 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In French).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The capital savings achieved by building large nuclear power plants are considerable, and medium-size utilities connected to an extensive grid may find it advantageous to join together in a large-scale collaborative project instead of building smaller power stations each for its own needs. Such utilities must then devise a suitable legal and financial framework for their joint venture, define at the very outset the rights and obligations of each partner, select the main contractor and establish the necessary administrative machinery for co-ordination of the project, supervision of the construction work and subsequent operation, and execution of production programs. Partnership companies which have been developed and adopted in Switzerland for carrying out most large hydroelectric projects (of both the run-of-the-river and the reservoir storage type) constitute a solution which — with certain modifications — could be easily adapted to the construction of large nuclear power stations undertaken jointly with a view to benefiting from economies of scale. This special form of electricity generating enterprise has proved itself over a period of many years, both nationally and internationally, and contributes significantly to the coordination of the activities of neighboring power networks. (auth)

34266 INFLUENCE OF NUCLEAR GENERATION ON THE PLANNING AND OPERATION OF INTERCONNECTED POWER SYSTEMS. Goldsmith, K. pp 683-94 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

If nuclear power is to be economically justified under present conditions, it has to involve large plant units operating at full output for long periods of time. The large blocks of nuclear energy thus becoming available will cause substantial changes in the generation pattern of the system into which the nuclear plant is introduced; their influence will extend also to neighboring systems with which there are effective interconnections. This influence on interconnected power systems is examined. In particular, the effect of nuclear generation on the contractual load flows between systems and the operational support which can be made available under normal conditions and in emergencies is discussed. The economic constraints limiting the zone of influence are also considered. Finally, it is shown to what extent nuclear generation is encouraged by active cooperation between neighboring power systems. (auth)

34267 SOME PROBLEMS CONNECTED WITH THE OPERATION OF NUCLEAR POWER STATIONS IN ELECTRIC POWER SYSTEMS, INCLUDING THOSE RELATING TO CO-OPERATION BETWEEN COMECON COUNTRIES IN THE NUCLEAR POWER ENGINEERING FIELD. Barchenkov, A.; Dosoudil, F.; Kroittsburg, M.; (and others). pp 695-704 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Certain problems are discussed relating to cooperation between Member States of COMECON in the expansion of the fuel and power sectors, the solution of which will contribute to the continued improvement of those countries' economy. It is pointed out that in the countries belonging to COMECON, the increase in electric power consumption is proceeding at a faster rate than the overall increase in the consumption of primary energy resources, and that the structure of the fuel and power sectors is definitely moving towards a proportional increase in the utilization of more efficient types of fuel and an intensive development of nuclear power engineering. As one alternative in the development of nuclear power engineering, the use in the immediate future is considered of pressurized water-cooled and moderated reactors (PWR) with unit capacities of 440 MW(e), adopted by most of the COMECON countries for installation in nuclear power stations, followed by transition to improved models with a capacity of 1000 MW(e) and to fast neutron reactors, so as to permit integration into the combined power systems of the COMECON countries in Europe. Certain considerations which enter into decisions on proper reactor utilization and the operational regimes of nuclear stations in power systems where it is a matter of developing large combined networks and interlinking them more closely are discussed. The extent to which increased nuclear power-station capacity is expected to affect the long-range structure of power generation capability in the COMECON countries is examined. The technical and economic feasibility is considered of the nuclear power stations operating in the modulated part of the load diagram at a time when the capacity of large nuclear power stations in combined power networks in the European countries belonging to COMECON will be increased, in terms of the versatility and flexibility of the stations and their technical and economic performance. Some ideas are put forward on possible ways of developing systems of this kind and on the range of voltages possible for inter-system and main transmission lines when large nuclear power stations are integrated into power networks. (auth)

34268 OPERATING EXPERIENCE WITH POWER REACTORS. Int. At. Energy Agency Bull.; 13: No. 2, 21-8(1971).

The operating history of nuclear power plants in IAEA member states is briefly summarized. The anticipated growth in operating power reactor units is discussed, and the cumulative energy production by nuclear power plants is indicated. (H.D.R.)

Safety and Siting

Refer also to abstract 32434.

34269 (DOCKET-50003-70) INDIAN POINT STATION, UNIT NO. 1. Remedial Measures Relative to Improperly Functioning Containment-Isolation Valves. (Consolidated Edison Co. of New York, Inc., New York). 6 May 1971. 4p. Dep. NTIS.

34270 (DOCKET-50003-71) INDIAN POINT STATION, UNIT NO. 1. Change No. 41 to Technical Specifications of Provisional Operating License No. DPR-5. (Division of Reactor Licensing (AEC), Washington, D. C.). 17 May 1971. 4p. Dep. NTIS.

Revised technical specifications concerning increased power levels and coolant temperatures with three operational primary coolant loops are presented. (D.C.C.)

34271 (DOCKET-50010-86) DRESDEN NUCLEAR POWER STATION, UNIT 1. Examination of the Crack in the Stub Riser. Final Report. (Battelle Memorial Inst., Columbus, Ohio). 29 Mar 1971. 18p. Dep. NTIS.

For Commonwealth Edison Co., Chicago, Ill.

Examinations have been conducted on the crack adjacent to the weld in the 4-inch pipe of the Type 304 stainless steel stub riser on a 22-inch loop line in the Dresden 1 Reactor. The crack was intergranular in the sensitized structure of the heat-affected zone adjacent to the weld. The crack appeared to initiate in a cold-worked layer that had been produced by grinding the inside surface of the pipe prior to welding. The appearance of the crack plus the fact that it progressed slowly and leaked indicated that stress-corrosion cracking was the mode of failure. The probable corrodent was the semistagnant BWR coolant. Chlorine and calcium were detected in the crack, but were discounted because these elements were also present in the solutions used in the dye-penetrant examinations that were conducted to locate the crack. (5 references) (auth)

34272 (DOCKET-50016-112) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. License No. DPR-9; Request for Authorization of Change No. 26 in the Technical Specifications. (Power Reactor Development Co., Detroit, Mich.). 12 May 1971. 7p. Dep. NTIS.

A request to change the reactor vessel support structure flex leg temperature limits is presented. The change will provide a more complete representation of the loadings which may act on the reactor vessel support structure. (D.C.C.)

34273 (DOCKET-50016-113) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. License No. DPR-9; Request for Authorization of Change No. 27 in the Technical Specifications. (Power Reactor Development Co., Detroit, Mich.). 19 May 1971. 9p. Dep. NTIS.

A request to change the maximum primary system cover gas pressure to 8 inches of water, gauge is presented. (D.C.C.)

34274 (DOCKET-50146-74) SAXTON REACTOR. License No. DPR-4; Technical Specifications Change Request No. 44.

(Saxton Nuclear Experimental Corp., Pa.). 5 May 1971. 6p. Dep. NTIS.

Revised technical specifications concerning Core 3 fuel modifications during mid-life fuel inspection are presented. The modifications provide for the irradiation of 12 pressurized Zircaloy-4 clad UO_2 pellet-type fuel rods in two load-follow assemblies. (D.C.C.)

34275 (DOCKET-50146-75) SAXTON REACTOR. License No. DPR-4; Amendment No. 1 to Change Report No. 24. (Saxton Nuclear Experimental Corp., Pa.). 11 May 1971. 14p. Dep. NTIS.

Information on the materials and design requirements of piping for auxiliary systems is presented. Line designations and piping systems classifications are also included. (D.C.C.)

34276 (DOCKET-50213-106) CONNECTICUT YANKEE ATOMIC POWER PLANT. Change No. 18 to Technical Specifications of Provisional Operating License No. DPR-14. (Division of Reactor Licensing (AEC), Washington, D. C.). 5 May 1971. 3p. Dep. NTIS.

Revised technical specifications are presented concerning increased fuel enrichment to 4.00 percent, increased limit of Zircaloy 4 clad fuel assemblies, and provisions for two NpO_2-ZrO_2 pellet-type target rods. (D.C.C.)

34277 (DOCKET-50237-163) DRESDEN NUCLEAR POWER STATION, UNIT 2. Plans for Inerting Primary Containment and Start-Up Test Program. (Commonwealth Edison Co., Chicago, Ill.). 6 May 1971. 2p. Dep. NTIS.

34278 (DOCKET-50245-58) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Change No. 2 to Technical Specifications of Provisional Operating License No. DPR-21. (Division of Reactor Licensing (AEC), Washington, D. C.). 26 Mar 1971. 1p. Dep. NTIS.

Modification of technical specifications concerning protection system instrumentation requirements during purging for containment inerting or deinerting is described. (D.C.C.)

34279 (DOCKET-50245-62) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Summary Report on Steam Line Movements Due to Dynamic Loading. (Millstone Point Co., Hartford, Conn.). 3 Mar 1971. 17p. Dep. NTIS.

34280 (DOCKET-50245-63) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Investigation of Necessity of Biological Shield Wall Modifications. (Millstone Point Co., Hartford, Conn.). 4 Mar 1971. 3p. Dep. NTIS.

34281 (DOCKET-50245-80) MILLSTONE NUCLEAR POWER STATION, UNIT 1. Changes Made to Correct Failure of Generator Lube-Oil Pump to Reach Required Pressure. (Millstone Point Co., Hartford, Conn.). 17 Nov 1970. 3p. Dep. NTIS.

34282 (DOCKET-50249-69) DRESDEN NUCLEAR POWER STATION, UNIT 3. Special Report No. 14: Hydrogen Flammability Control System in a Boiling Water Reactor. (Commonwealth Edison Co., Chicago, Ill.). 24 May 1971. 48p. Dep. NTIS.

34283 (DOCKET-50250-9) TURKEY POINT PLANT, UNITS NO. 3 AND 4. Preliminary Safety Analysis Report, [Amendment 5], Suppl. 5. (Florida Power and Light Co.). 7 Oct 1966. 157p. (DOCKET-50251-8). Dep. CFSTI.

Information requested by the Division of Reactor Licensing is presented. Meteorological data for the reactor site are included. (D.C.C.)

34284 (DOCKET-50254-36) QUAD-CITIES STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 23. (Commonwealth Edison Co., Chicago, Ill. Iowa-Illinois Gas and Electric Co., Davenport, Iowa). 11 May 1971. 34p. (DOCKET-50265-33). Dep. NTIS.

Additional data on the reactor requested by the Division of Reactor Licensing are presented. (D.C.C.)

34285 (DOCKET-50267-29) FORT ST. VRAIN NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 20 (Includes Revised Pages to Final Safety Analysis Report). (Public Service Co. of Colorado, Denver). 3 May 1971. 91p. Dep. NTIS.

Revised and additional information concerning emergency diesel generator and core nuclear characteristics is presented. (D.C.C.)

34286 (DOCKET-50282-33) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Environmental Report, Operating License Stage. (Northern States Power Co., Minneapolis, Minn.). 12 May 1971. 179p. (DOCKET-50306-33). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

34287 (DOCKET-50282-34) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9 (Includes Reactor-Auxiliary-Turbine Building, Earthquake Analysis and Response Acceleration Spectra). (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). 11 May 1971. 183p. (DOCKET-50306-34; JAB-PS-2; JAB-PS-4). Dep. NTIS.

For Northern States Power Co., Minneapolis, Minn.

34288 (DOCKET-50293-49) PILGRIM NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 29, Responses to ACRS Comments. (Boston Edison Co., Mass.). 17 May 1971. 18p. Dep. NTIS.

34289 (DOCKET-50295-26) ZION STATION, UNITS 1 AND 2. Environmental Report. (Commonwealth Edison Co., Chicago, Ill.). 17 May 1971. 414p. (DOCKET-50304-26). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

34290 (DOCKET-50301-32) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Detailed Statement on the Environmental Considerations. (Division of Radiological and Environmental Protection (AEC), Washington, D. C.). 6 May 1971. 444p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

34291 (DOCKET-50305-20) KEWAUNEE NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 9 (Includes Reactor-Auxiliary-Turbine Building, Earthquake Analysis and Response Acceleration Spectra). (Blume (John A.) and Associates, Engineers, San Francisco, Calif.). 8 May 1971. 135p. (JAB-PS-1; JAB-PS-3). Dep. NTIS.

For Wisconsin Public Service Corp., Green Bay.

34292 (DOCKET-50312-25) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Environmental Report. (Sacramento Municipal Utility District, Calif.). 18 May 1971. 335p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Geological, hydrological, and meteorological data for the reactor site and surrounding area are included. (D.C.C.)

34293 (DOCKET-50317-25) CALVERT CLIFFS NUCLEAR POWER PLANT, UNITS 1 AND 2. Study of the Effects of Mislocated Vertical Tendons. (Baltimore Gas and Electric Co., Md.). 13 May 1971. 44p. (DOCKET-50318-25). Dep. NTIS.

Information concerning the mislocated vertical tendons of the prestressed post-tensioned concrete containment structures is presented. Corrective actions are described. (D.C.C.)

34294 (DOCKET-50335-19) HUTCHINSON ISLAND PLANT, UNITS 1 AND 2. Environmental Report, Vol. 1. (Florida Power and Light Co.). 20 May 1971. 300p. (DOCKET-50389-7). Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

34295 (DOCKET-50338-30) NORTH ANNA POWER STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 15. Report on Design and Stability. (Stone and Webster Engineering Corp., Boston, Mass.). 13 May 1971. 449p. (DOCKET-50339-29). Dep. NTIS.

For Virginia Electric and Power Co., Richmond.

Information on the design and stability of the North Anna Dam is presented under the following main headings: project description; seepage control; soils properties; seismic response; embankment; and spillway. (D.C.C.)

34296 (DOCKET-50341-29) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 17 May 1971. 103p. Dep. NTIS.

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34297 (DOCKET-50358-15) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 9. (Cincinnati Gas and Electric Co., Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 12 May 1971. 335p. Dep. NTIS.

Revised and additional information is presented on the following topics: personnel training and qualifications; conduct of operations; quality assurance program; resolution of ACRS concerns; procedures for the seismic analysis of structures and equipment; analysis of underground service water pipes and supporting pipes; and answers to AEC questions. (D.C.C.)

34298 (DOCKET-50358-16) WM. H. ZIMMER NUCLEAR POWER STATION, UNIT 1. Environmental Report, Amendment No. 1. (Cincinnati Gas and Electric Co., Columbus, Ohio. Columbus and Southern Ohio Electric Co., Columbus, Ohio. Dayton Power and Light Co., Ohio). 12 May 1971. 37p. Dep. NTIS.

Revised and additional information concerning chemical, radioactive, and thermal discharges from the reactor is presented. (D.C.C.)

34299 (DOCKET-50366-9) EDWIN I. HATCH NUCLEAR PLANT, UNIT 2. Preliminary Safety Analysis Report, Amendment 2. (Georgia Power Co., Atlanta). 12 May 1971. 106p. Dep. NTIS.

Revised design parameters for the Edwin I. Hatch Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

34300 (DOCKET-50367-13) BAILLY GENERATING STATION, NUCLEAR I. Preliminary Safety Analysis Report, Amendment 6. (Northern Indiana Public Service Co., Hammond). 4 May 1971. 149p. Dep. NTIS.

Revised and additional data on the Bailly Power Reactor Unit 1 are presented. (D.C.C.)

34301 (DOCKET-50368-10) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Amendment 5. (Arkansas Power and Light Co., Little Rock). 19 May 1971. 225p. Dep. NTIS.

Revised design parameters of the Arkansas Nuclear One Power Reactor Unit 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. (D.C.C.)

34302 (DOCKET-50369-9) McGUIRE NUCLEAR STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Duke Power Co., Charlotte, N. C.). 25 May 1971. 442p. (DOCKET-50370-8). Dep. NTIS.

Revised design parameters of the McGuire Power Reactor Units 1 and 2 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Geological and hydrological data for the reactor site are presented. (D.C.C.)

34303 (DOCKET-50373-7) LA SALLE COUNTY STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 1. (Commonwealth Edison Co., Chicago, Ill.). 27 Apr 1971. 189p. (DOCKET-50374-7). Dep. NTIS.

Additional data on reactor site geology are presented. Revised and additional data are also included for reactor core cooling system, containment system, emergency core cooling system, radioactive waste systems, auxiliary systems, and steam and power conversion system. (D.C.C.)

34304 (DOCKET-50376-13) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Preliminary Facility Description and Safety Analysis Report, Amendment 5. (Puerto Rico Water Resources Authority, San Juan). 14 May 1971. 407p. Dep. NTIS.

Revised design parameters of the Aguirre Power Reactor Unit 1 are presented. Included also are additional data on the reactor requested by the Division of Reactor Licensing. Meteorological data for the reactor site are listed. (D.C.C.)

34305 (DOCKET-50376-14) AGUIRRE NUCLEAR PLANT, UNIT NO. 1. Environmental Report. (Puerto Rico Water Resources Authority, San Juan). 21 May 1971. 293p. Dep. NTIS.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. Meteorological data for the reactor site are included. (D.C.C.)

34306 (DOCKET-50387-9) SUSQUEHANNA STEAM ELECTRIC STATION, UNITS 1 AND 2. Notice of Receipt of Application for Construction Permits and Facility Licenses. (Division of Reactor Licensing (AEC), Washington, D. C.). 30 Apr 1971. 3p. (DOCKET-50388-9). Dep. NTIS.

34307 (DOCKET-50389-1) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Application for Licenses. (Florida Power and Light Co.). 1 May 1971. 50p. Dep. NTIS.

Financial data on the owners of the Hutchinson Island Power Reactor Unit 2 are presented in support of the application for construction permit and operating license. The 1970 Annual Report for the Florida Power and Light Company is included. (D.C.C.)

34308 (DOCKET-50389-2) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Preliminary Safety Analysis Report, Pt. A, Vol. 1 (Comprises Preliminary Safety Analysis Report Unit 1 Updated Through Amendment 9 to Include Unit 2). (Florida Power and Light Co.). 1 May 1971. 628p. Dep. NTIS.

Information on Hutchinson Island Power Reactor Unit 2 is presented under the following broad topics: site and environment; and reactor. (D.C.C.)

34309 (DOCKET-50389-3) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Preliminary Safety Analysis Report, Pt. B, Vol. 2. (Florida Power and Light Co.). 1 May 1971. 600p. Dep. NTIS.

Information on Hutchinson Island Power Reactor Unit 2 is presented under the following broad topics: reactor coolant system; containment system; engineered safeguards; instrumentation and control; electrical systems; auxiliary systems; steam and power conversion system; waste management and radiation protection; conduct of operations; initial tests and operations; and safety analysis. (D.C.C.)

34310 (DOCKET-50389-4) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Preliminary Safety Analysis Report, Pt. B, Vol. 3. (Florida Power and Light Co.). 1 May 1971. 493p. Dep. NTIS.

Information requested by the Division of Reactor Licensing is presented. Meteorological data for the reactor site and surrounding area are included. (D.C.C.)

34311 (DOCKET-50389-5) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Preliminary Safety Analysis Report, Pt. B, Vol. 4. (Florida Power and Light Co.). 1 May 1971. 800p. Dep. NTIS.

Information on Hutchinson Island Power Reactor Unit 2 is presented concerning foundation investigations. (D.C.C.)

34312 (DOCKET-50389-6) HUTCHINSON ISLAND PLANT, UNIT NO. 2. Preliminary Safety Analysis Report, Pt. B, Vol. 1. (Florida Power and Light Co.). 1 May 1971. 428p. Dep. NTIS.

Information on Hutchinson Island Power Reactor Unit 2 is presented under the following broad topics: site and environment; reactor; reactor coolant system; containment system; engineered safeguards; instrumentation and control; electrical systems; auxiliary systems; steam and power conversion system; waste management and radiation protection; conduct of operations; initial tests and operations; safety analysis; and technical specifications. (D.C.C.)

34313 (JPRS-53069, pp 96-106) ASPECTS OF RADIATION SAFETY DURING PLANNING AND OPERATION OF CHANNEL-TYPE POWER REACTORS. Veselkin, A. P.; Beskrestnov, N. V.; Sklyarov, V. P.; Khandamirov, Yu. E.; Yashnikov, A. I. Translated from At. Energ. (USSR); 30: 144-9(1971).

Radiation levels in the cooling and power conversion systems of the two units of the Beloyarsk Nuclear Power Plant are analyzed. (21 references) (H.D.R.)

34314 (NP-18797(Vol.1)) JERVIS BAY NUCLEAR POWER STATION INVESTIGATIONS FOR CIVIL WORKS, VOLUME 1, SUMMARY OF GEOLOGY, HYDROGRAPHY, AND SITE DEVELOPMENT. McKinnon, C. K. (Electricity Commission of New South Wales (Australia). Civil Investigations Branch). Dec 1970. 30p. Dep. NTIS (U. S. Sales Only).

A brief description of the site is given, together with summaries of the geological and hydrographical investigations. Cost estimates for the cooling water system civil works are made for flow rates from 800 to 1200 cusecs, for five alternative outfalls, and for an infall conduit. Based on these estimates as well as technical and amenity considerations outfall recommendations are made depending upon whether an ocean or a bay outfall is selected. Additional investigations which are considered necessary are outlined. (Australia)

34315 (NP-18797(Vol.2)) JERVIS BAY NUCLEAR POWER STATION INVESTIGATIONS FOR CIVIL WORKS, VOLUME 2,

GEOLOGY AT SITE JS2 MURRAYS BEACH. MacGregor, J. P. (Electricity Commission of New South Wales (Australia). Civil Investigations Branch). Dec 1970. 400p. Dep. NTIS (U. S. Sales Only).

Investigations carried out to determine the geology and foundation conditions in the area south and west of Murrays Beach, Jervis Bay (the area for a proposed nuclear power station) are detailed. Field investigations include geological mapping, geophysical surveys and drilling (auger and diamond). Results are depicted. Photogeological, petrographic, rock strength and soils investigations were also carried out, and contributed to the choice of a site. Types of material which would be encountered and various cooling water conduit locations were examined. (11 references) (Australia)

34316 (NP-18797(Vol.3)) JERVIS BAY NUCLEAR POWER STATION INVESTIGATIONS FOR CIVIL WORKS. VOLUME 3. SURVEYS AND HYDROGRAPHIC INVESTIGATIONS. Hawkins, R. B. (Electricity Commission of New South Wales (Australia). Civil Investigations Branch). Dec 1970. 185p. Dep. NTIS (U. S. Sales Only).

Surveys and hydrographic investigations which have been carried out at Jervis Bay for the proposed nuclear power station site are described. Detailed climatic information for the site is given. Information on tides, waves, currents and the effect of these on cooling water intake and outfall locations are presented. A power station basement level is recommended and the extent of warm water spread and recirculation is discussed. Details of hydraulic investigations which have been carried out for preliminary design of structures for cost estimates are also given. (3 references) (auth) (Australia)

34317 NUCLEAR POWER AND ITS CRITICS. THE CAYUGA LAKE CONTROVERSY. Nelkin, Dorothy. Science, Technology, and Society Series. Ithaca, N. Y.; Cornell University Press (1971). 138p. $1.75.

Information is presented concerning environmental effects of Bell Station Power Reactor operation on the Cayuga Lake and surrounding area. Issues discussed include: the conflict between the need for increased power capacity and concern about the environmental effects of power generation; the problem of developing policy for ecological protection; and the effect of opposition groups on decisions involving environmental change. (D.C.C.)

34318 OUR ENVIRONMENT: OPTIONS ON THE WAY INTO THE FUTURE. Sporn, Philip. IEEE (Inst. Elec. Electron. Eng.), Spectrum; 8: No. 5, 49-58(May 1971).

Predicted power requirements and fuel resources for the U. S. are discussed. The effects of electric power production on the environment are analyzed. A program for compatibility in the development of electric power plants and the preservation of the environment is outlined. (D.C.C.)

Power Reactor Development

34319 (CONF-701123) CONFERENCE ON THE ASSESSMENT OF OUR FUEL AND ENERGY RESOURCES AND REQUIREMENTS, BRISBANE, QUEENSLAND, 4th-6th NOVEMBER 1970. (Institute of Fuel (Australian Membership)). 286p.

Topics on the optimum utilization of fuel resources in Australia for generating electricity are discussed. Separate abstracts are included for 3 of the 20 papers presented. The remaining 17 papers discuss fossil fuel resources and utilization. (D.C.C.)

For abstracts of individual papers see: 34320, 34351, and 34382.

34320 (CONF-701123-, Paper 1) NUCLEAR ENERGY IN AUSTRALIA. Warner, R. K.; Baxter, J. P. (Australian Atomic Energy Commission). 16p.

From Conference on the assessment of our fuel and energy resources and requirements; Brisbane, Australia (4 Nov 1970).

In Conference on the assessment of our fuel and energy resources and requirements, Brisbane, Queensland, 4th-6th November 1970.

Reactor types and major overseas programs for nuclear power are reviewed, and an outline is given of future developments. At present in the world the capacity of nuclear power stations in operation, under construction, or committed, totals some 129,500 MW(e). By 1980 the installed nuclear generating capacity outside the Soviet area should be 250,000 to 300,000 MW(e), and in 1990 the U. S. alone is expected to have 500,000 MW(e) of nuclear plant in operation. Nuclear power has been established as a technically and economically viable industry, which will not add to atmospheric pollution. The proposed nuclear power station at Jervis Bay heralds the beginning of Australia's nuclear power industry, which is destined to play a major role in the development of this country. By 1985 nuclear power stations should be competitive with conventional stations in all States of the Commonwealth, except possibly Tasmania, and the installed nuclear generating capacity is expected to be 4,000 MW(e). By the turn of the century Australia could have 36,000 MW(e) of nuclear power in operation, representing about one-third of the country's total installed generating capacity. The introduction of nuclear power into Australia will give rise to new ancillary industries, such as fuel fabrication and reprocessing. Nuclear energy has made an important contribution in the field of radioisotopes and radiation applications. In the future it is expected to lead to new developments in Australia in saline water conversion, civil and mining engineering uses of nuclear explosives, and possibly in "nuclear energy centers" for agro-industrial complexes. These applications are surveyed briefly. (auth)

34321 (JPRS-53069) CEMA NUCLEAR PROGRAM. Translated from At. Energ. (USSR); 30: 91-185; 192-234(1971). 262p. NTIS.

Included are 25 papers from the nineteenth session of the Council of Economic Mutual Aid. Topics discussed include design and performance characteristics of water-cooled reactors and sodium-cooled fast reactors. Reactor fuel element and steam supply system component development and testing are examined. A separate abstract was prepared for each of the papers. (H.D.R.)

For abstracts of individual papers see: 34197-34201, 34225-34228, 34313, 34322, 34323, 34334, 34335, 34353-34357, 34378, 34384, 34385, 34389, 34403, and 34439.

34322 (JPRS-53069, pp 139-46) EXPERIENCE OF CONSTRUCTION AND STARTUP OF THE BOR-60 REACTOR. Leypunskii, A. I.; Kazachkovskii, O. D.; Baturov, B. B.; (and others). Translated from At. Energ. (USSR); 30: 165-9(1971).

Some of the problems encountered in the design, construction, and startup of the sodium-cooled fast reactor BOR-60 are briefly discussed. (H.D.R.)

34323 (JPRS-53069, pp 166-75) THE BRG-30 EXPERIMENTAL POWER INSTALLATION WITH GAS-COOLED FAST NEUTRON REACTOR AND DISSOCIATING HEAT TRANSFER MEDIUM. Krasin, A. K.; Nesterenko, V. B.; Kolykhan, L. I.; Tverkovkin, B. E.; Slizov, V. P.; Shufrov, Yu. V.; Greben'kov, Zh. L.; Bubnov, V. P.; Lomashev, B. I. Translated from At. Energ. (USSR); 30: 180-5(1971).

The design parameters of a conceptual 30 MW(t) gas-cooled fast reactor are presented. The coolant is nitrogen tetroxide (N_2O_4), which is used in single-circuit gas-liquid cycle. (H.D.R.)

34324 OPTIMIZATION OF GAS-COOLED FAST REACTORS. Lys, L. A.; Mayor, J. C. (Swiss Federal Inst. for Reactor Research, Wuerenlingen, Switzerland). J. Brit. Nucl. Energy Soc.; 10: 140-50(Apr 1971).

The general role of optimization in the design of nuclear power plants is discussed, and the principles of the optimization methods employed are described. Some results of GCFR parametric studies are presented, following a short description of the plant concept. (auth) (UK)

34325 FILLING THE VOIDS IN FAST REACTOR TECHNOLOGY. Nelson, R. Stuart (Atomic Energy Research Establishment, Harwell, Eng.). New Sci. Sci. J.; 49: 664-7(25 Mar 1971).

Structural materials damaged by the high neutron doses in fast breeder reactors can swell by dangerous amounts over several years. This unanticipated problem for the new technology of fast reactors threatens their safety and economic viability. Using particle accelerators, those materials which can withstand the extreme conditions have been screened. (auth) (UK)

34326 REACTOR FUELING METHOD. Greebler, Paul (to United States Atomic Energy Commission). U. S. Patent 3,575,803. 20 Apr 1971. Filed 8 Aug 1968.

A refueling method for a fast neutron sodium-cooled nuclear breeder reactor system which involves positioning fuel elements containing fissile fuel having a ^{240}Pu isotope content greater than 25% adjacent the breeder blanket at the core periphery and placing fuel elements having a ^{240}Pu isotope content less than 8% near the central region of the core. The result is a lowering of the positive coolant void reactivity in the central region. New fuel placed near the center core region is shuffled to the core periphery in an organized manner. (auth)

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Kinetics and Dynamics

34327 (BNWL-1553) CRITICAL EXPERIMENTS WITH THE UO_2-2 wt.PERCENT PuO_2 BATCH CORE IN THE PRTR. Smith, R. I.; Kutcher, J. W.; Lauby, J. H.; Williams, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb 1971. Contract AT(45-1)-1830. 95p. Dep. NTIS.

The initial phase of the Batch Core Experiment comprised the loading of a new core of UO_2-2 wt % PuO_2 fuel elements and the performance of a series of critical tests to determine the physics parameters of this new core. Measurements included the critical loadings for boron concentrations ranging from zero to about 21 ppm by weight (wppm) of ^{10}B in the D_2O moderator, moderator level coefficients of reactivity over a 25-inch range of moderator heights at several boron concentrations, moderator void worths, thermal neutron flux distributions within the core, the effect of loss of coolant from fuel channels, fuel element worths, and kinetics parameters. The results of these measurements are presented. At specified burnup levels during the Batch Core Experiment, interim critical tests were conducted. These tests included measurements of core excess reactivity, fuel element worths, poison rod worths, and kinetics parameters. The results of these measurements are also presented. 8 references. (auth)

34328 SOME PROBLEMS OF KINETICS OF COUPLED REACTORS. Vatulin, V. V.; Yuferev, V. I. This paper was summarized in At. Energ. (USSR); 29: 117(Aug 1970) as paper No. 409/5445. (In Russian).

The temporal behavior of a system of coupled fast and thermal reactors is investigated for the case of linear time-variation of reactivity in the fast reactor. (auth)

Control Systems

34329 (CEA-N-1421) EL-600: NEUTRONIC STUDY OF CORE CONTROL SYSTEMS. Chabrillac, Marcel; Goldstein, Stephen; Micaux, Bernard; Naudet, Roger; Tran Tuc Vi (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Feb 1971. 68p. (In French). Dep. NTIS (U. S. Sales Only).

EL 600 is the design of a 600 MW(e), heavy water moderated and cooled reactor of the Canadian type. The control was studied by separating the various functions and their related devices: overall control rods, zone control rods, adjuster rods, safety rods. The efficiency of various control mechanisms, such as rods, and moderator poisoning, was defined after studies of operating conditions have dealt with normal or accidental transients. (17 references) (auth) (France)

34330 PROCESS FOR STABILIZING THE POWER OF A LIQUID COOLED AND MODERATED REACTOR. Cachera, Pierre Charles (to Electricite de France). French Patent 1,598,100. 29 Jun 1970. Filed 24 Dec 1968. (In French).

A process for stabilizing the power of a liquid cooled and moderated reactor (boiling light water or heavy water) is described. The moderator is contained in a vessel traversed by vertical canals, containing the fuel elements, and in which boiling liquid coolant circulates. Variations in reactivity due to the formation of vapor bubbles in the boiling coolant liquid are compensated by the appearance of a variable quantity of gas bubbles in the moderator. The process consists of allowing the moderator to boil and producing vapor bubbles whose volumes and locations vary with the reactivity in the canals. The coolant and the moderator circulate in two parallel identical circuits and in the same sense. The vaporized coolant is separated from the liquid which is sent back into the reactor at a controlled velocity, while the vaporized moderator is cooled and sent back into the reactor vessel under a controlled pressure, which depends on the vaporization to be obtained. (auth) (France)

34331 CONTROL AND STABILITY ANALYSIS OF THE PINCH-FISSION FAST-BREEDER CAVITY REACTOR. King, Wen-juin. Pittsburgh; Univ. of Pittsburgh (1970). 145p. University Microfilms Order No. 71-9029.

Thesis.

The idea of converting nuclear energy directly into electricity was considered in light of the cavity reactor concept. A novel configuration for a pinch-fission fast-breeder cavity reactor is described. It converts directly fission energy liberated in a gaseous reactor core on the stabilized pinch principle. The pinch-fission fast-breeder cavity reactor concept and control and stability problems associated with this new direct energy conversion system are examined. A toroidal cylindrical cavity core contains high temperature fissionable gas and is surrounded by a reflector. An externally caused azimuthal field is applied to confine the fission gas and to compress it into a critical configuration. Nuclear fission energy, when taken through a compression-expansion cycle, does work on the confining magnetic field. The electric power is extracted directly by a coil-condenser tuned resonant tank circuit which links the magnetic field. The pinch-fission cavity reactor can be designed as a fast breeder reactor by utilizing ^{239}Pu as the fuel and ^{238}U as the fertile species. In this case, the cavity core contains high temperature ^{239}Pu gas and a blanket surrounding the cavity core contains ^{238}U. No moderator is present in the reflector region so that the majority of fissions are produced by fast neutrons. From the control and stability view points, the results obtained from both the analytical and the computer simulation methods indicate that the pinch-fission fast-breeder cavity reactor system has a sufficient inherent self regulating mechanism. It can be operated as a safe, stable power generating system and can meet the operating requirements of the electric utility industry. A properly designed automatic control system can further improve the system stability and meet electric load variations. (Diss. Abstr. Int., B)

34332 OPERATING AND LOAD-FOLLOWING PERFORMANCE OF A BOILING-WATER REACTOR POWER PLANT. Carbon, P.; Stephan, W. (AEG-Telefunken, Frankfurt am Main). pp 139-53 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

With the growing importance of nuclear power stations it is necessary to adjust their features to the demands of the interconnected grids. The main problem is to provide to the grid as fast as possible the energy demands of the customers. The BWR can fulfill these requirements. In the reactor core the steam is generated and fed directly to the turbine which makes the plant very compact and have a fast response. Compared with similar reactors, the void coefficient leads to a reactivity feedback factor 3 to 4 times stronger. Therefore the time lag in power changing is lower by the same factor. The so-called flow control conducts to a fast load variation without changing the power distribution in the reactor core. As a result of BWR philosophy, reactor power follows the coolant flow through the core immediately and within a wide range. By simultaneously moving several control rods (group moving) a high control velocity is realized all over the load range (full power to minimum at 10%) and starting time is significantly reduced (up to full power within one hour). By developing the control devices and the control conception to the present state BWRs have shown great flexibility. Further advantages are to be foreseen. Thus, BWR power stations can be operated as peak-load plants providing an economical integration into the interconnected grid during all the designed life of 40 years. BWRs are able to fulfill the demands of the grid and to provide the technical conditions for the economic integration of nuclear power stations in electric power systems. 8 references. (auth)

Shielding

34333 (COO-2049-4) FAST NEUTRON TRANSMISSION MEASUREMENTS FOR REACTOR CORE AND SHIELDING MATERIALS. Technical Progress Report (1971). Meyer, Walter (Kansas State Univ., Manhattan. Dept. of Nuclear Engineering). Mar 1971. Contract AT(11-1)-2049. 66p. Dep. NTIS.

Research to design and perform double differential fast neutron transmission experiments for semi-infinite slabs of several important reactor core construction and shielding materials including concrete, iron, water and laminated assemblies of these materials of precisely defined structure is described. These experiments are designed to generate fast neutron penetration data that are necessary to complete complex core shielding analyses as well as to test and evaluate fast neutron transport codes. 27 references. (auth)

Cooling Systems

34334 (JPRS-53069, pp 188-96) DEVELOPMENT AND STUDY OF PEARLITIC STEELS FOR STEAM GENERATORS OF NUCLEAR POWER UNITS WITH SODIUM HEAT TRANSFER MEDIUM. Kapyrin, G. I.; Gorynin, I. V.; Gribov, N. N.; Balandin, Yu. F.; Shurakov, S. S.; Trapeznikov, Yu. M. Translated from At. Energ. (USSR); 30: 198-202(1971).

Properties of carbon steels for use in sodium-heated steam

generator tubes are examined. The corrosive effects of sodium on alloys of various composition are investigated. (11 references) (H.D.R.)

34335 (JPRS-53069, pp 197-203) ESTIMATE OF USABILITY OF AUSTENITIC STEELS FOR NUCLEAR POWER UNITS WITH SODIUM HEAT TRANSFER MEDIUM. Kapyrin, G. I.; Gribov, N. N.; Balandin, Yu. F.; Shurakov, S. S.; Ivanova, T. I. Translated from At. Energ. (USSR); 30: 203-6(1971).

The results of studies on the suitability of austenitic stainless steels for use in cooling systems of sodium cooled reactors are presented. The mechanical properties and corrosion resistance of two basic alloys are examined. (H.D.R.)

34336 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SECTION III. WINTER 1970 ADDENDA. New York; American Society of Mechanical Engineers (1970). 45p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34337 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SECTION III. SUMMER 1970 ADDENDA AND ERRATA. New York; American Society of Mechanical Engineers (1970). 30p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34338 RULES FOR INSERVICE INSPECTION OF NUCLEAR REACTOR COOLANT SYSTEMS. ASME BOILER AND PRESSURE VESSEL CODE. SECTION XI. New York; American Society of Mechanical Engineers (1970). 28p. Available from American Society of Mechanical Engineers, New York.

Requirements for in-service inspection of pressure containing components of water cooled reactor cooling systems, associated auxiliary systems, and emergency core cooling systems are presented. The requirements cover classification of areas subject to inspection, responsibilities, provisions for accessibility, definitions of examination methods, examination techniques, personnel qualifications, frequency of inspection, records, mapping, evaluation of inspection results, and disposition and repair criteria. (H.D.R.)

34339 ANALYSIS OF REACTOR VESSEL RADIATION EFFECTS SURVEILLANCE PROGRAMS. Steele, L. E.; Serpan, C. Z. Jr. ASTM Special Technical Publication 481. Philadelphia; American Society for Testing and Materials (1970). 270p. Available from American Society for Testing and Materials, Philadelphia.

Pertinent information concerning the influence of neutrons on the properties of pressure vessel materials is reviewed. Specific aspects of reactor pressure vessel surveillance are summarized in chapters on: (1) basis for vessel surveillance; (2) neutron embrittlement of reactor vessel steels; (3) Army reactor vessel surveillance; (4) commercial reactor vessel surveillance; (5) neutron dosimetry and spectrum; and (6) surveillance programs critique and recommendations. (H.D.R.)

34340 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SUMMER 1968 ADDENDA. New York; American Society of Mechanical Engineers (1968). 14p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34341 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. WINTER 1968 ADDENDA. New York; American Society of Mechanical Engineers (1968). 8p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34342 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SECTION III. WINTER 1969 ADDENDA. New York; American Society of Mechanical Engineers (1969). 15p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34343 RULES FOR CONSTRUCTION OF NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SECTION III. New York; American Society of Mechanical Engineers (1968). 238p. Available from American Society of Mechanical Engineers, New York.

Requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. Vessels specified by the code include those which are designed to contain the reactor coolant or moderator, separate the coolant or moderator from the heat transfer medium, and collect nuclear waste from the system. Requirements for new construction and for mechanical and thermal stresses due to cyclic operation are provided. (H.D.R.)

34344 NUCLEAR STEAM SUPPLY SYSTEMS. PTC 32.1 1969. New York; American Society of Mechanical Engineers (1969). 33p. Available from American Society of Mechanical Engineers, New York.

Procedures for conducting tests to determine the thermal performance of water cooled reactor steam supply systems are presented. The tests include capacity, reactor power level, efficiency, steam pressure, moisture content, solids in the steam, and other related operating characteristics. A supplement on the selection and calibration of the instruments used is included. (H.D.R.)

34345 DRAFT ASME CODE FOR PUMPS AND VALVES FOR NUCLEAR POWER. New York; American Society of Mechanical Engineers (1968). 213p. Available from American Society of Mechanical Engineers, New York.

Proposed rules for the materials, design, manufacture, examination, testing, and certification requirements for pumps and valves for water cooled nuclear power plant applications are presented. The pumps and valves are divided into three classes or quality levels and the requirements for each class are discussed in separate sections. (H.D.R.)

34346 FABRICATION FOR THE AGRs. Greener, R. (Whessoe Ltd., Darlington, Eng.). Weld. Metal. Fabr.; 39: 116-21(Apr 1971).

The fabrication and erection systems used for liners and gas baffles for the AGR stations at Hinkley Point "B" and Hunterston "B" are described. A description of the development and fabrication of the diagrids is also included, as their design incorporates several new features. (UK)

34347 NUCLEAR VESSELS. ASME BOILER AND PRESSURE VESSEL CODE. SUMMER 1969 ADDENDA. New York; American Society of Mechanical Engineers (1969). 49p. Available from American Society of Mechanical Engineers, New York.

Revised requirements for the materials, design, fabrication, inspection, testing, and certification of vessels for use in nuclear power plants are presented. (H.D.R.)

34348 CHANGES IN THE ACOUSTICALLY INDUCED VIBRATION OF REACTOR GAS CIRCUIT COMPONENTS CAUSED BY VARYING THE OPERATING CONDITIONS. Stearn, S. M.; Whitton, P. N. (Central Electricity Generating Board, Berkeley, Eng.). J. Brit. Nucl. Energy Soc.; 10: 121-9(Apr 1971).

If, during the lifetime of a reactor, it is necessary to change the operating conditions, acoustically induced dynamic stresses may also be altered. Changes in gas condition will alter both the sound power generated by the circulator and the strength of the coupling between the acoustic field and the structure. By studying the response of a structural mode at resonance under various gas conditions, the changes of stress are predicted. In general it is found that the stress will be increased by a reduction in gas temperature or an increase in mass flow. (auth) (UK)

34349 REACTOR COOLANT PUMPS GET PREMIUM MOTORS. Pastor, C. E. Power; 114: No. 12, 40-1(Dec 1970).

Design characteristics and requirements of vertical high-speed induction motors for circulating primary coolant in pressurized-water reactors are described. (D.C.C.)

34350 HEAT TRANSFER AND FLUID FLOW STUDIES FOR THE DEVELOPMENT OF A NUCLEAR REACTOR: THE EXAMPLE OF CIRENE AND THE POSSIBLE CONNECTIONS WITH OTHER INDUSTRIAL PROBLEMS. Cerral, E.; Hassid, A. (CISE, Milan). Energ. Nucl. (Milan); 18: No. 4, 228-38(Apr 1971). (In Italian).

The origin and development of the heat transfer and fluid flow studies carried out by CISE in support of the CIRENE reactor are described. The problems which have been analyzed in the various phases of this work and the possible connections with other applications are discussed. (auth)

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Fuels

Refer also to abstract 32687.

34351 (CONF-701123–, Paper 9) FUELS FOR ELECTRICITY GENERATION IN AUSTRALIA. Evans, D. G. (Melbourne Univ., Parkville (Australia)). 25p.

From Conference on the assessment of our fuel and energy resources and requirements; Brisbane, Australia (4 Nov 1970).

In Conference on the assessment of our fuel and energy resources and requirements, Brisbane, Queensland, 4th–6th November 1970.

The generation of electrical power accounts for nearly half the fuel used in Australia. The present and future fuel usage pattern in this industry is therefore of vital importance to the balanced development of Australia's fuel resources. In the past coal has been the principal fuel for electricity generation. However, with the development of new deposits of oil, gas, and nuclear fuels over the last few years, diversification can be expected, with the choice of fuel being made mainly for economic reasons. Nuclear power generation is not expected to become competitive with generation from fossil fuels until the early nineteen eighties in New South Wales and Victoria, and much later in the less populous States. Thus, except for specific non-economic reasons, nuclear stations will not be built for at least another ten years. In the meantime, with power consumption doubling every few years in most parts of Australia, a great development in coal-burning stations for base load, and oil and gas stations for peak load, can be expected in the eastern States, with oil and gas being used for both purposes in South Australia and Western Australia. (8 references) (auth)

34352 (IN–1456) BURNUP DETERMINATION FOR FAST BREEDER REACTOR FUELS: PROGRAM OBJECTIVES AND PLANS. Maeck, W. J.; Lisman, F. L. (Idaho Nuclear Corp., Idaho Falls). Feb 1971. Contract AT(10-1)-1230. 25p. Dep. NTIS.

A new program was initiated to develop methods for the accurate determination of nuclear fuel burnup in fast breeder reactor fuels. The objectives of the program are presented and the planned experimental program is outlined. (auth)

34353 (JPRS–53069, pp 204-14) ESTIMATION OF EFFICIENCY OF FAST REACTOR FUEL ELEMENT ENVELOPES. Likhachev, Yu. I.; Proshkin, A. A.; Shcherbakov, Zh. N. Translated from At. Energ. (USSR); 30: 206-11(1971).

The effects of internal and external pressures and thermal stresses on cylindrical fuel element cans are examined. The effects of uneven temperature distribution on swelling of steel cans are calculated. (18 references) (H.D.R.)

34354 (JPRS–53069, pp 215-24) STUDY OF PROSPECTIVE FUEL COMPOSITIONS BASED ON URANIUM AND PLUTONIUM CARBIDE FAST REACTORS. Golovnin, I. S.; Men'shikova, T. S.; Reshetnikov, F. G.; (and others). Translated from At. Energ. (USSR); 30: 211-16(1971).

The characteristics of carbide fuel compositions for fast reactors are discussed. The compositions of carbides produced by various methods, tests of carbide compatibility with steel fuel cans, and the effects of irradiation on carbide fuels are discussed. (H.D.R.)

34355 (JPRS–53069, pp 225-35) SOME PROBLEMS IN THE DEVELOPMENT OF FUEL ELEMENTS FROM FAST REACTORS. Golovnin, I. S.; Bibilashvili, Yu. K.; Men'shikova, T. S.; Medvedev, A. V.; Kalashnik, G. V. Translated from At. Energ. (USSR); 30: 216-21(1971).

The development of fuel elements for fast reactors is examined. Problems in the selection of fuel density, the effects of heating, porosity of fuel pellets, fuel can thickness and deformation, and the reduction of swelling are discussed. Aspects of the use of carbide fuel in fast reactors are analyzed. (H.D.R.)

34356 (JPRS–53069, pp 245-8) DESIGN AND PRINCIPAL CHARACTERISTICS OF THE VVER-1000 FUEL ELEMENT. Zaymovskii, A. S.; Kalashnikov, V. V.; Kostrov, V. N.; Malanchenko, L. L.; Nikulina, A. V.; Yamnikov, V. S. Translated from At. Energ. (USSR); 30: 226-8(1971).

Design and performance parameters of fuel elements for a 1000 MW(e) water cooled reactor are presented and compared to fuel element parameters for existing reactors. (H.D.R.)

34357 (JPRS–53069, pp 249-55) STUDY OF FUEL ELEMENTS IN A CASETTE FOLLOWING 17,000 HOURS OPERATION IN THE CORE OF THE VK-50 REACTOR. Belokopytov, V. S.; Votinov, S. N.; Sapychev, V. M.; Dem'yanovich, M. A.; Petin, B. P.; Andreeva, A. B.; Derivizov, M. D.; Shchepetil'nikov, V. A. Translated from At. Energ. (USSR); 30: 228-31(1971).

The results of post-irradiation examinations on a zirconium-niobium alloy clad uranium dioxide fuel element are presented. The effects of the long-term irradiation on microstructure and mechanical properties are discussed. (H.D.R.)

34358 (LA–4669) SODIUM-BONDED (U,Pu)C FUEL ELEMENTS AFTER MODERATE BURNUP. Barner, J. O. (Los Alamos Scientific Lab., N. Mex.). Apr 1971. Contract W-7405-eng-36. 29p. Dep. NTIS.

Two sodium-bonded, single phase ($U_{0.8}Pu_{0.2}$) C fueled, Type 316 stainless steel clad fuel elements were irradiated in EBR-II at heating rates of ~30 kW/ft to burnups of 3.7 and 5.0 at. %. No clad failures occurred as a result of the irradiation. Total fission gas release from the fuel was low. Thermal stresses in the fuel resulted in fuel splitting upon initial startup and general fuel fragmentation as fission product recoil and fast neutron damage accumulated. No new phases were observed in the fuel after irradiation. 8 references. (auth)

34359 (LA–4675) USE OF HIGH-RESOLUTION GAMMA-RAY SPECTROMETRY FOR DETECTING FAILURE OF CLADDING IN ENCAPSULATED FAST REACTOR FUEL PINS. Phillips, J. R.; Schulte, J. W.; Waterbury, G. R. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 5p. Dep. NTIS.

A nondestructive technique utilizing precision gamma-ray scanning was developed for detecting fuel cladding failure in doubly encapsulated fast reactor fuel elements. Detection of fission products, in particular ^{137}Cs, outside the fuel pin envelope was used to indicate the failure. The method was tested by examining eleven mixed uranium-plutonium carbide and two mixed uranium-plutonium oxide fuel elements. Gamma-ray scanning indicated that six of the thirteen fuel elements had failed. These results were confirmed by mass spectrometric analysis of the gases in the outer encapsulation which were found to contain 11.7 to 65.0% xenon and 1.76 to 9.31% krypton. The cover gas from a seventh pin contained only 0.016% xenon and <0.003% krypton, and the presence of ^{137}Cs outside the cladding was not conclusively detected by gamma-ray scanning. Cesium-137 was not found in the outer encapsulation of the six other fuel elements by gamma-ray scanning, and mass spectrometric analyses confirmed that the cladding had not failed. (auth)

34360 (RT/ING–(70)29) VENTING DEVICE FOR SODIUM COOLED FAST CERAMIC REACTOR FUEL ELEMENTS: DESIGN STUDY AND OUT OF PILE TESTS. Bertoncello, G.; Gerosa, A.; Martini, M. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 Nov 1970. 62p. (CONF-681101–47). Dep. NTIS (U. S. Sales Only).

From International conference on the constructive uses of atomic energy, Washington, D. C.

In the frame of the Italian Fast Reactor Program (P.R.V.) a study of hydraulic type venting devices was made. Preliminary out of pile tests verified that the double capillary venting device chosen presents good performance under stationary and transient conditions. (11 references) (auth)

34361 CONFERENCE ON FAST REACTOR FUEL ELEMENT TECHNOLOGY, APRIL 13–15, 1971, NEW ORLEANS, LOUISIANA. Farmakes, Ruth (ed.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 1-42(1971). (CONF-710414).

Included are summaries of 40 papers on the design and irradiation performance of fast reactor fuel elements. Each paper is listed separately by title in NSA. (H.D.R.)

For abstracts of individual papers see: 32648, 32796–32808, 32847–32859, 34362–34373, 34414, and 34415.

34362 LMFBR FUEL DESIGN: WHY CAN'T WE DO BETTER. Kintner, E. E. (Atomic Energy Commission, Washington, D. C.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 1(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34363 ROTATING WIRE SPACER MODEL IN LARGE-BUNDLE THERMAL HYDRAULICS. Kolesar, D. C. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 3(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34364 SENSITIVITY ANALYSIS OF SUBASSEMBLY SHROUD MECHANICAL PERFORMANCE. Burchill, William E.; Menzel, Gerhart (Combustion Engineering, Windsor, Conn.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 3-5(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34365 MIXED-OXIDE FUEL PIN PERFORMANCE ANALYSIS USING THE OLYMPUS COMPUTER CODE. Boltax, A.; Biancheria, A. M.; Harbourne, B. L.; Soffa, T. P. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 6(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34366 FINE TUNING AN FBR FUEL MODELING CODE. Nathan, M. E.: Schweinberg, R. N. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 6-7(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710415.

34367 PRACTICAL RESULTS ON FAST REACTOR OXIDE FUEL PIN DEVELOPMENT AND MODELING ACTIVITIES. Karsten, G.; Kummerer, K.; Geithoff, D.; Kaempf, H. G. (Kernforschungszentrum, Karlsruhe, Ger.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 7-8(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34368 THERMAL PERFORMANCE LIMITS FOR FAST REACTOR OXIDE FUELS. Christensen, J. A. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 14-15 (1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34369 EFFECTS OF BURNUP ON FUEL PIN THERMAL PERFORMANCE. Biancheria, A.; Nayak, U. P.; Beck, M. S. (Westinghouse Electric Corp., Madison, Pa.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 15-16(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34370 THERMAL PERFORMANCE OF FUEL RODS AND THE PERFORMANCE OF LMFBR'S. Sayles, C. W.; Nathan, M. E. (Atomics International, Canoga Park, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 16-17(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34371 PERFORMANCE OF MIXED-OXIDE FUEL ELEMENTS: ANL EXPERIENCE. Neimark, L. A.; Dickerman, C. E.; Lambert, J. D. B.; Murphy, W. F. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 22-3(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34372 STEADY-STATE IRRADIATION PERFORMANCE OF UO_2–PuO_2 FAST REACTOR FUELS. Craig, C. N.; Perry, K. J.; Duncan, R. N.; (and others). (General Electric Co., Sunnyvale, Calif.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 23-4(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34373 FUEL DYNAMICS EXPERIMENTS ON FAST REACTOR OXIDE FUEL PERFORMANCE UNDER TRANSIENT HEATING CONDITIONS USING THE TREAT REACTOR. Dickerman, C. E.; Deitrich, L. W.; Robinson, L. E.; Rothman, A. B.; Carter, J. C. (Argonne National Lab., Ill.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 28-9(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34374 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR COMPONENTS. Jones, Philip Michael: Walsh, Raymond Herbert (to United Kingdom Atomic Energy Authority). British Patent 1,228,769. 21 Apr 1971. Filed 23 Nov 1967.

Reference is made to reactors of the gas cooled graphite moderated type designed for on-load refuelling. With such reactors, while a fuel stringer is being raised or lowered during refuelling, the action of the coolant flow can cause lateral vibration of the stringer in the fuel channel or charge pipe, with the possibility of damage to the stringer. The object of the arrangement described is to provide means for preventing or minimizing such vibration. At least one of the lower fuel elements in the stringer is provided with radially projecting spring bristles, arrayed in a circumferential band for the purpose of resiliently bracing the stringer from the fuel channel wall. The spring bristles are preferably fitted to the bottom end of the lowermost fuel element in the stringer. (UK)

34375 THERMIONIC FUEL ROD WITH NUCLEAR FUEL. Gross, Franz; Jester, Alfred; Krapf, Rudolf; Holick, Hubert (to Brown, Boveri and Cie AG.). U. S. Patent 3,563,856. 16 Feb 1971. Priority date 5 Aug 1966, Germany.

The thermionic elements comprise tubular, concentrically positioned emitters and collectors. The fuel elements are electrically connected in series and are provided with respective discharge chambers which are separated from each other by novel vacuum-tight seals, the seals providing a mechanical and electrical separation of the respective thermionic elements. The discharge chamber, provided at one end of each thermionic element, is filled with cesium vapor. The novel seal comprises a discshaped rigid metal-ceramic component at one end, and a pliable or yieldable metal–ceramic portion acting as a guide ring at the other end, acting in combination with a vacuum-tight plate. (auth)

34376 URANIUM FEED AND SEPARATIVE WORK REQUIREMENTS FOR NUCLEAR POWER PLANTS. Kuhn, D. W. (Atomic Energy Commission, Washington, D. C.). pp 65-78 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The demands made on a ^{235}U isotope separations plant by nuclear power stations using enriched uranium, in whole or in part, as fuel are described. The types of reactors considered which require enriched uranium are pressurized and boiling light-water reactors, the advanced gas-cooled reactor, and the high-temperature gas-cooled reactor. A new nuclear power unit must be furnished initially with a complete reactor loading of fuel. Annual requirements for fuel replacement are a small fraction of the initial requirement. This characteristic of nuclear fueling results in a large initial demand on the isotope separations plant followed by smaller requirements for make-up. Enriched uranium requirements are expressed as requirements for diffusion plant feed and separative work. A summary is given of feed and separative work required to date by a number of operating reactors, and these figures are compared with trends in reactors under construction or planned for the future. Considerations which could affect the requirements are discussed, including the effect of operating the diffusion plant at different tails assays, choosing different irradiation levels and hence different ^{235}U enrichments for reactor fuel cycles, increasing the specific power of reactors, and recycling plutonium or ^{233}U in thermal reactors. The requirements for individual reactors are coupled with the forecast of nuclear power capacity to estimate annual and cumulative requirements for natural uranium ore and for isotope enriching services. (auth)

34377 FUEL SUBASSEMBLY FOR A LIQUID-METAL-COOLED, FAST BREEDER REACTOR. Jakub, Marlyn T.; Hesson, Galen M.; Anthony, Andy J. (to United States Atomic Energy Commission). U. S. Patent 3,575,808. 20 Apr 1971. Filed 21 Mar 1969.

A fast reactor includes a plurality of fuel subassemblies arranged so that the upper ends are further apart than are the lower ends. Each fuel subassembly includes a bundle of slender, elongated cylindrical fuel pins which are inclined in conical array over that part of the pins which contains the fuel and which are parallel over that part of the pins which contains a fission-gas plenum. The fuel pins are spaced from each other and from the walls of the shroud surrounding the bundle of fuel pins by spacer wires which are of gradually increasing cross section from the bottom to the top of that part of the fuel pin containing the fuel and are of uniform cross section over that portion of the fuel pin containing the fission-gas plenums. (auth)

Auxiliary and Emergency Systems

Refer also to abstracts 32208 and 34390.

34378 (JPRS–53069, pp 131-8) TESTING OF THE SEAL OF FUEL ELEMENT ENVELOPES IN REACTORS WITH GAS HEAT TRANSFER MEDIA. Gladki, E.; Melikhar, E.; Kubik, I.; Kapishovski, V. Translated from At. Energ. (USSR); 30: 162-5(1971).

Methods for detection of defected fuel elements in gas cooled reactors are examined. The results of studies performed to evaluate the electroprecipitation and the filtration methods for use in the A-1 reactor cooling system are presented. (11 references) (H.D.R.)

34379 SYSTEM FOR THE REMOVAL OF HYDROGEN FROM NUCLEAR REACTOR CONTAINMENT STRUCTURES. (to Westinghouse Electric Corp.). British Patent 1,230,547. 5 May 1971. Priority date 3 Feb 1969, United States.

REACTOR CONTAINMENT STRUCTURES — ventilation system for water cooled reactor, description of hydrogen removal

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REACTORS, WATER-COOLED—containment structure for, description of hydrogen removal ventilation system for
VENTILATION—containment structure hydrogen removal, description of water cooled reactor, (D.C.C.)

34380 RELIABILITY OF THE EMERGENCY POWER SUPPLY OF A NUCLEAR POWER PLANT WITH GAS COOLED REACTOR. Staubli, O. N. (Brown, Boveri und Cie AG, Mannheim, Ger.). BBC-Nachr.; 52: 363-9(1970). (In German).

The reliability of components and systems and a probability calculation of the plant safety are presented. The breakdown of the energy supply is considered for three different requirement groups: consuming devices with breakdown allowed; breakdown only momentarily allowed; and breakdown not allowed. (INIS)

34381 FUEL HANDLING SYSTEM OF THE PEBBLE-BED REACTOR AND ITS INFLUENCE ON THE AVAILABILITY OF THE POWER PLANT. Hantke, H.-J. (Brown Boveri/Krupp Reaktorbau GmbH, Cologne). pp 165-74 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The system of fuel handling in the pebble-bed reactor is very simple. It predicts a high availability of the power plant because it does not require any machinery for fuel handling inside the reactor. The only core equipment are pipes connected to the appropriate points at the core periphery. Pneumatic energy is used for the upward motion and gravity for downward flow of the spheres. Therefore the different machines are accessible for maintenance or repair work during operation of the reactor, except the "severilizer" which separates the core exit from the fuel-handling system. In the event of failure of this device, the reactor must be shut down and depressurized. Another advantage of the continuous recirculation of pebbles is the relatively high specific burnup that can be achieved, because when they circulate through the core they remain for only a short period in the zone of high temperature. This will result in a good reliability of the coatings and consequently a low radioactive contamination of the primary circuit. This concept of a pebble-bed reactor was first put into practice in the AVR Experimental Power Station. After recirculation of nearly 200,000 spheres the fuel-handling facilities have demonstrated their feasibility in spite of some "teething problems" of this newly developed system. During operation of the plant only two failures required shut-down and depressurization. In all other malfunctions of the fuel-handling facility the operation of the power plant was not interrupted. Some faults are described in detail. One fault demonstrated another advantage of this type of fuel element when the "damaged-sphere separator" incorrectly acted as if the elements were undamaged and therefore threw the undamaged elements into the scrap container thereby jamming this machine. Because of the distribution of the total amount of uranium on some ten thousand fuel elements, each individual fuel element contains no more than 1 g of uranium and hence a relatively low radioactivity. Thus it was possible to extract these irradiated fuel elements by means of an industrial vacuum cleaner and to repair the defective scrap separator during operation of the plant. The experience gained with the AVR fuel-handling facility is used for improving the THTR fuel-handling system so that the availability of this prototype is expected to be even higher. 3 references. (auth)

Operation and Economics

34382 (CONF-701123–, Paper 8) STUDY OF NUCLEAR FUEL CYCLE STRATEGIES FOR AUSTRALIA. Hayes, J. E.; Herbert, J. B.; Slizys, R. A. (State Electricity Commission of Victoria (Australia)). 19p.

From Conference on the assessment of our fuel and energy resources and requirements; Brisbane, Australia (4 Nov 1970).

In Conference on the assessment of our fuel and energy resources and requirements, Brisbane, Queensland, 4th–6th November 1970.

The results and main conclusions from a program of nuclear power investigations carried out within the State Electricity Commission of Victoria during the period 1967 to 1969 are presented. The objective of the work was to determine the appropriate timing for the establishment of nuclear fuel cycle facilities in Australia, and the likely scope of nuclear power generation. (11 references) (auth)

34383 (DOCKET-50231-82) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Primary Drain Tank Venting System Malfunction. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 14 May 1971. 8p. Dep. NTIS.

34384 (JPRS-53069, pp 147-55) EFFECTIVENESS OF FUEL UTILIZATION IN FAST POWER REACTORS. Orlov, V. V.; Troyanov, M. F.; Lytkin, V. B. Translated from At. Energ. (USSR); 30: 170-4(1971).

Fuel cycle characteristics of fast breeder reactor systems are discussed. The various factors affecting the consumption of fuel in breeder only systems and in mixed systems of thermal and fast reactors are described and their effects on fuel cycle optimization are examined. (H.D.R.)

34385 (JPRS-53069, pp 156-65) PROBLEM OF SELECTING THE PARAMETERS OF A LARGE FAST REACTOR. Kazachkovskii, O. D.; Krasnoyarov, N. V.; Nikol'skii, R. V.; Grachev, E. A.; Ziganshin, T. M.; Kirillov, E. V.; Sekletsova, R. E. Translated from At. Energ. (USSR); 30: 174-9(1971).

The effects of core heat rating, core configuration, breeding factor, thermal efficiency, and fuel type on fast breeder reactor optimization are examined. Characteristics of reactors with variations in blanket composition and configuration and with oxide or metal fuel are compared. (H.D.R.)

34386 EFFECTS OF MULTIPLE ENRICHMENT RADIAL CORE ZONING ON THE NEUTRONIC AND ECONOMIC CHARACTERISTICS OF A LARGE FAST BREEDER REACTOR. Doherty, Patrick Kirby. Lafayette, Ind.; Purdue Univ. (1970). 294p. University Microfilms Order No. 71-9387.

Thesis.

A study of the effect of multiple enrichment radial core zoning on several neutronic and economic characteristics of large fast breeder reactors which have from one to five radial enrichment zones was performed. The five core designs studied were prepared in a consistent manner from the German Na-1 design. A constant core volume constraint was used to minimize bias. Additional design bases included equal distribution of core volume in the enrichment zones and equilibrium fuel cycle analysis. The initial fuel compositions of the core zones were adjusted to achieve a flat power distribution. The analysis consisted of neutronic and economic calculations. Most of the neutronic analysis was done with one-dimensional diffusion theory codes. This includes criticality-power distribution searches and isotopic depletion calculations. Two-dimensional diffusion theory was used to check some of the one-dimensional results. The economic analysis included levelized fuel cycle cost calculations for each reactor, capital cost per unit installed capacity for each reactor based on capital costs scaled from the capital costs for a reference reactor, total unit cost of generating power for each reactor, and the annual cost savings gained by using each incremental core zone. The principal results of the study are summarized. (Diss. Abstr. Int., B)

34387 SIZE EFFECT AND COST OF INCREMENTAL CAPACITY FOR LIGHT-WATER REACTORS. Zmola, P. C. (Combustion Engineering Inc., Windsor, Conn.). pp 43-56 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Studies involving integration of nuclear plants in overall utility system planning as well as evaluation of differential plant capacity of alternatives for a specific plant require a simple yet valid relationship of total plant cost to plant capacity. Simplicity in application requires that the relationship be continuous. Validity requires that any analytic expression of the cost-capacity relationship be derived from actual costs of nuclear plants under construction or in operation. Total electric generating plant costs reported within the past two years for 41 nuclear units going into commercial service from 1969 to 1976 were fitted with three expressions to represent the cost-capacity relationship. The plants ranged in electrical capacity from approximately 480 to 1150 MW(e). It was found that either a linear cost-capability expression or the familiar expression of cost proportional to the electrical capability raised to an exponential power fitted the data equally well. The average plant costs from the fitted expressions were $240/kW(e) at 500 MW(e), $210/kW(e) at 800 MW(e), and $190/kW(e) at 1100 MW(e). The median start-up date for these plants is 1973. The cost of incremental capacity was found to be approximately 75% of the average cost of capacity for the plant size under consideration. A range of ±15% encompassed one standard deviation of the data fitted by the exponential expression. The study was confined to light-water-moderated and cooled reactors being planned, constructed and operated in the

United States. No distinction has been made between boiling-water and pressurized-water systems since both appear to compete effectively in the United States utility market. 5 references. (auth)

34388 INTEGRATION OF DISTRICT-HEATING NUCLEAR POWER STATIONS INTO INTERCONNECTED POWER SYSTEMS. Halzl, J.; Szabo, Z.; Torma, M. (Inst. for Energetics, Budapest). pp 123-37 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The operational conditions of nuclear district-heating power stations and their expected role in the power system are analyzed. Because of the increased length of the district-heating network compared with conventional district-heating systems, efforts have to be made to reduce the specific investment costs of heat distribution. Proposals for the combination of district heating with electrical heating which not only reduces the costs of heat distribution but also helps to utilize cheap off-peak nuclear power are presented. A combination of district heating with hot-water production using off-peak nuclear power which, in addition to reducing the capacity requirement of the district-heating network, also offers an attractive solution to the problem of hot-water supply in the summer period is described. If there is a demand for district cooling in the summer period in addition to the heating requirements in winter, the combination of district heating with a heat pump might become an economic proposition. The heat pump is much superior to direct electrical heating and thermodynamically equivalent to the back-pressure system. It helps to reduce the capacity requirement of district heating and at the same time increases the consumption of off-peak power. If the distance between the power station and the residential area is too great, the heat pump alone might become competitive. (auth)

Safety and Siting

34389 (JPRS-53069, pp 64-73) SOME SAFETY PROBLEMS OF AEPS WITH WWPR. Ostashenko, V. F.; Bumblis, I. I.; Alpatov, A. M. Translated from At. Energ. (USSR); 30: 127-32 (1971).

The reactivity control, nuclear, thermal, and hydraulic characteristics of water cooled power reactors are examined. Potential accident situations and reactor protection measures are discussed. (H.D.R.)

34390 (NEDO-10329) LOSS-OF-COOLANT ACCIDENT AND EMERGENCY CORE COOLING MODELS FOR GENERAL ELECTRIC BOILING WATER REACTORS. Slifer, Bruce C.; Hench, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1971. 239p.

The procedures and models used to analyze loss-of-coolant accidents for boiling water reactors are described. The range of applicability of the various models as a function of break size and type is defined. Typical results of the analyses are shown and related to the final results which are used to judge the adequacy of the core standby cooling systems in meeting their design criteria. Each individual model is described in detail, with the key assumptions and equations defined. The adequacy of each model is supported through analyses and by experimental verification. Finally, the sensitivity of the final results to variations in the key parameters is assessed. The study shows the models to be adequate tools for the study of the loss-of-coolant accidents and the capability of the core standby cooling system adequate in dealing with them. 18 references. (auth)

34391 (NYO-4217-1) MATHEMATICAL ANALYSIS OF THERMAL POLLUTION OF LAKES AND ESTUARIES. Progress Report. Hundal, Mahendra S.; Martinek, Frank (Vermont Univ., Burlington). 25 Feb 1971. 15p. Dep. NTIS.

Progress for the period June 1, 1970 through February 1971 is reported. The mathematical models for the three regimes of the problem; entry, mixing and heated plume, were developed. The programs for analyzing the entry and heated plume were written and checked either against closed form solutions or published data taken on Lake Monona in Wisconsin. The program for the mixing regime was written and is being checked out. Data for the actual Lake Champlain problem was taken and is being reduced. Future objectives of the project were established. They are: (1) to add aeration and chemical dispersion computational capabilities to the model together with an ice barrier; (2) to complete a study of a fossil-fuel plant; and, (3) to add a cathode ray tube display capability to the program. (auth)

34392 (ORNL-4647) NUCLEAR SAFETY PROGRAM. Annual Progress Report for Period Ending December 31, 1970. (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 273p. Dep. NTIS.

CHARCOAL — combustion of, effects of fission product decay heat on
FISSION PRODUCTS — release from failed pyrolytic carbon coated particle type reactor fuels
GRAPHITE — corrosion by steam under high temperature gas cooled reactor accident conditions, (E)
HEAT TRANSFER SYSTEMS — construction of LMFBR Failed Fuel Mockup
HYDROGEN — production by water cooled reactor containment sprays, analysis of radiolytic
INFORMATION CENTERS — operations of Nuclear Safety, during January to December 1970
IODINE — removal by containment spray systems, (E)
LIQUID METAL FAST BREEDER REACTOR — fuel element bundles for, effects of flow blockage on temperature distribution in, (E)
METHANE, IODO- — removal by sodium thiosulfate spray solutions
— removal by containment spray systems, (E)
NEUTRONS, FAST — effects on mechanical properties of A533 HSST steel plates
NOZZLES — stress in, effects of configuration on
NUCLEAR SAFETY PILOT PLANT — spray systems in, iodine and methyl iodide removal by, (E)
PIPE FITTINGS — stress analysis for T-shaped cylinder
REACTOR CONTAINMENT SYSTEMS — effectiveness of sodium thiosulfate additive in spray, for removal of methyl iodide
REACTOR FUEL ELEMENTS — failure of Zircaloy clad uranium oxide (UO_2) rod type, effects of coolant loss on, (E)
— temperature distribution in liquid metal cooled bundle arranged, effects of flow blockage on, (E)
REACTOR FUELS — fission product release from failed pyrolytic carbon coated particle type
REACTOR SAFETY — research and development program during January to December 1970, analysis of ORNL
— standards for development of water cooled reactors
REACTOR SAFETY EXPERIMENTS — fuel element failure in TREAT, effects of coolant loss on Zircaloy clad uranium oxide (UO_2) rod type, (E)
REACTORS, BOILING — containment spray system for, radiolytic hydrogen generation by
REACTORS, GAS-COOLED — fuels for high temperature power, fission product release from failed particle type
REACTORS, POWER — fuels for high temperature gas cooled, fission product release from failed particle type
REACTORS, PRESSURIZED-WATER — containment spray system for, radiolytic hydrogen generation by
REACTORS, WATER-COOLED — fuel elements for, effects of coolant loss on failure of Zircaloy clad
— containment system for, effects of sodium thiosulfate additive on removal of methyl iodide in
SODIUM THIOSULFATES — effectiveness in removal of methyl iodide by spray solutions
STEAM — corrosive effects on graphite under high temperature gas cooled reactor accident conditions, (E)
STEEL — mechanical properties of plate shaped HSST, effects of thickness on
— radiation effects on mechanical properties of A533 HSST, fast neutron
TUBES — failure of Zircaloy, testing for high temperature, (E)
WELDED JOINTS — stress analysis for T-shaped cylinder
ZIRCALOY — tubes of, testing for high temperature failure of, (E) (D.C.C.)

34393 (ORNL-TM-3342) ORNL NUCLEAR SAFETY RESEARCH AND DEVELOPMENT PROGRAM BIMONTHLY REPORT FOR JANUARY-FEBRUARY 1971. Cottrell, Wm. B. (Oak Ridge National Lab., Tenn.). May 1971. Contract W-7405-eng-26. 127p. Dep. NTIS.

The accomplishments during the months of January and February in the research and development program on nuclear safety are summarized. Much of this work is in general support of water-cooled power reactor technology, including LOFT and industry programs, and reflects current safety problems, such as measurements of prompt fuel element failure phenomena and the problems associated with the long-term operation of containment spray systems. Several projects are also conducted in support of the high-temperature gas-cooled reactor (HTGR) and liquid-metal fast breeder reactor (LMFBR) programs. Other major projects are those on primary piping and steel pressure-vessel technology. They also include experimental investigations of the attachment

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of nozzles to shells and the implementation of joint AEC-PVRC programs on heavy-section steel technology and nuclear piping, pumps, and valves. Seismic considerations of particular significance in nuclear plant design are being evaluated in the seismic program. Several of the above projects are also directly related to the AEC's standards program, which entails development of engineering safeguards and the establishment of codes and standards for government-owned or -sponsored reactor facilities. The recent activities of NSIC and the Nuclear Safety journal in behalf of the nuclear community are also discussed. Of particular interest in both of these activities is the recent emphasis on environmental effects. (auth)

34394 DRAFT ASME CODE FOR IN-SERVICE TESTING OF VALVES IN NUCLEAR POWER PLANTS. New York; American Society of Mechanical Engineers (1970). 15p. Available from American Society of Mechanical Engineers, New York.

Rules are presented for conducting and reporting periodic in-service tests and inspections of values in water cooled nuclear power plants. The rules apply to valves whose function is vital to systems for the prevention of accidents or to the mitigation of the consequences of accidents. (H.D.R.)

34395 ENVIRONMENTAL RADIATION FROM PRESSURISED WATER REACTORS. Wright, J. H. (Westinghouse Electric Corp., Pittsburgh). J. Inst. Nucl. Eng.; 12: 8-12(Jan-Feb 1971).

A quantitative assessment of the exposure of the general public to ionizing radiation resulting from the nearby operation of nuclear power plants is presented. It is important to quantify the average exposure levels which might result to the general population from power plants in order to determine the existence or magnitude of public health problems which might result from a proliferation of nuclear power plants in a given area. Results of the investigation indicate that the most likely average exposure to the general population from a large PWR power station is extremely low (essentially zero). It would also appear that the radiation effects in a region containing multiple nuclear plants on 32 km center-to-center location are still quite negligible. These analyses are based on extrapolating PWR design and operating experience. It should be noted that in order to assess the possible future environmental distribution of radionuclides released from power plants, it will become increasingly important to have occasional isotopic analysis information on liquid and gaseous effluents and while there appears to be no immediate or short range problem with the build-up of radionuclides in the biosphere, the management of krypton and, to some extent tritium, should be modified within the next two decades. (auth) (UK)

Power Conversion Systems

34396 IMPROVEMENTS TO VAPOR GENERATORS INTENDED FOR NUCLEAR POWER PLANTS. (to Babcock-Atlantique). French Patent 1,599,566. 15 Jul 1970. Filed 30 Dec 1968. (In French).

An in-vessel vapor generator for an energy production plant is described. It is intended that the vapor generator be connected to a hot source cooled by a primary fluid and adopted to transmit heat coming from the source to a secondary fluid circulating in an array of tubes of an exchanger. In this array of tubes an evaporator is connected to a superheater by an intermediate pipe, a portion of which is situated exterior to the array of tubes, e.g., outside the vessel. A device situated in this part of the pipe enables the superheater to be blocked and the recycling to the evaporator of the secondary fluid leaving and, in addition to injecting water into the secondary fluid circuit. The exchanger tubes are connected to the collector by the intermediate of a tubular plate. The generator chamber is closed by two lids, between which the tubular plates are situated. The parts of the tubes or collectors associated with a plate and situated between the lids are surrounded by a protective envelope: a gas source maintains the gas pressure in the space between the lids equal to the primary. (auth) (France)

34397 PRINCIPLES OF TURBINE SELECTION FOR NUCLEAR POWER STATION REACTORS. Arsen'ev, Yu. D. (Inst. of Power Engineering, Moscow). pp 57-64 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971). (In Russian).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

In spite of the fact that the specific costs of electric power from nuclear and conventional power stations are quite similar, they differ considerably in their structure. The optimal design solutions for nuclear power stations operating in a power system may thus differ considerably from the designs adopted for normal stations. One of the characteristic features of nuclear power stations is the production of secondary fuel, so that the higher the conversion ratio the greater must be the station load factor and the stricter the requirement of reliable operation. It is therefore advantageous to use a nuclear power station for the base part of the load curve and a fossil fuel station for the semi-peaking or peaking regions. With the increasing size of nuclear power stations, however, they will certainly start to be used in the semi-peaking region as well, and this will affect the type of reactor and the optimal design parameters of the station as a whole. The relationship between the reliability and the capacity of different items of equipment of a nuclear power station is analyzed. This general relationship finds concrete expression in the choice of the number of turbines per reactor. It is shown that, whereas for conventional stations the simple reactor-turbine unit is preferable, for a nuclear power station of large capacity it is advantageous to use two turbines per reactor. It is pointed out that even with damage to one turbine the nuclear power station can continue working at reduced capacity and—the main advantage—there is no need to include special emergency equipment to provide heat removal for shut-down cooling of the reactor core. 5 references. (auth)

34398 NUCLEAR POWER PLANTS WITH INTEGRATED STEAM ACCUMULATORS FOR LOAD PEAKING. Gilli, P. V. (Univ. of Tech., Graz); Fritz, K. pp 79-93 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

The ratio of nuclear plant capacity to total installed capacity is rising rapidly. Depending on the load duration curve and the proportion of hydraulic power, nuclear plants will therefore either have to take part, to some extent, in following the daily load pattern or some means will have to be provided for storing the extra energy produced during low-load periods for the peak periods. (This would result in high annual load factors and a reduction in installation costs which would pay for the cost of the storage plant.) With the expected introduction into the power industry of the fast breeder with its low fuel cost, the problem will become even more important. Integrated storage devices within the steam cycle, such as steam or hot-water accumulators, have not proved very successful with conventional plants since it is generally cheaper to overdesign the boiler and force the turbine by tripping one or several feed heaters. However, these arrangements are not suitable for nuclear plants, mainly because grossly overdesigning the reactor is economically out of the question. On the other hand, the integration of steam accumulators with nuclear plants is much more attractive than with conventional plants because of the different cost structure. Increasing the load factor of a nuclear plant brings about a proportionally greater gain than with a conventional plant. Therefore, accumulators should be economical for nuclear plants whenever they lead to a marked improvement for the load factor by permitting the plant to remain under full load during off-peak time, thereby charging the accumulators. Several new features of the flow sheet and design of a nuclear plant with integrated accumulators are described. A preliminary economic assessment shows that even the simplest scheme of the proposed arrangement with a separate accumulator turbine compares favorably with any other method of coping with daily load peaks. Such a scheme involves only a small cost increase and the better load factor of the nuclear power plant leads to considerable economic gains. 19 references. (auth)

34399 NUCLEAR POWER PLANT IN COMBINATION WITH GAS TURBINE PEAKING UNITS. Streeton, D. F.; Emerson, D. C. (Burmot Engineering Consultants Ltd., London). pp 105-14 of Economic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

A new approach is proposed to provide lower peak-load energy costs by combining gas-turbine packages with a nuclear power plant. It is shown that the peaking generation efficiency can be improved by over 40% by using such a combination and this leads to a reduction in peaking energy costs of over 20%. Other overall technical and economic advantages of this concept are also discussed. 6 references. (auth)

34400 ECONOMIC AND SITING POTENTIAL OF NUCLEAR POWER PLANTS WITH HIGH-TEMPERATURE REACTOR AND HELIUM TURBINE. Foerster, S.; Schroeder, B.; Schlenker, H. V. (Kernforschungsanlage, Juelich, Ger.). pp 155-63 of Eco-

nomic Integration of Nuclear Power Stations in Electric Power Systems. Vienna; International Atomic Energy Agency (1971).

From Symposium on economic integration of nuclear power stations in electric power systems; Vienna, Austria (5 Oct 1970). See STI/PUB-266; CONF-701031.

Technologically, power plants with a high-temperature reactor and a closed-cycle helium turbine (HTR-GT) may be feasible for reactor outlet-gas temperatures of 1000°C or even higher. For these temperatures the application of the dry-air cooling system is very attractive. Therefore it is important to know the economic potential of HTR-GT power plants at these high temperatures for power units with an electrical output of up to about 2000 MW(e) and with an air cooling system. The thermodynamic consequences on economic plant layout, resulting from maximum cycle temperatures between 900 and 1300°C, are established. The influence of the maximum cycle temperature on optimum values for the minimum process temperature and on the recuperative heat exchanger efficiency is analyzed. It is shown that the economic layout of the dry-air cooling system is possible. On the basis of cost values for a specified plant the design aspects of the plant are investigated for power units between 500 and 2000 MW(e). Since the influence of the maximum cycle pressure on the size and on the costs of the plant components is pronounced for HTR-GT power plants the variation of the maximum cycle pressure in the range from 60 to 120 bar is taken into account. From these investigations conclusions are drawn on the appropriate choice of the maximum cycle pressure and of the overall design (integrated or non-integrated) depending on the electrical power of the plant. The expected changes in electricity generating costs due to increasing maximum cycle temperature and pressure and increasing electrical power of the plant are shown. 5 references. (auth)

Research and Test Reactors

Refer also to abstract 34392.

34401 (ANL-7789) SIZE DISTRIBUTION OF BUBBLES EMITTED FROM SIMULATED CLADDING BREAKS. Anderson, R. P.; Bova, L.; Roop, C. J. (Argonne National Lab., Ill.). Mar 1971. Contract W-31-109-eng-38. 43p. Dep. NTIS.

The size of fission product gas bubbles released from a simulated break in fuel-element cladding was studied experimentally and analytically. Experiments were performed with a simple gas-ejection loop with the following parametric variation: five gas plenum pressures from 50 to 500 psig, six liquid velocities from 5 to 32 ft/sec., two simulated break diameters, 0.0005 and 0.0016 in., and two ejected gases, argon and nitrogen. For each combination of experimental parameters, the gas ejection area was photographed. Enlargements of the photographs supplied information on the gas-bubble size and the bubble-generating mechanism. Different bubble-generating mechanisms were reviewed. An equation relating bubble diameters calculated from the equation correlated well with bubble diameters measured from the photographs. (auth)

34402 (CEA-R-4152) EQUIVALENT SAMPLE METHOD FOR ANALYZING OSCILLATION EXPERIMENTS ON FISSIONABLE SAMPLES IN A THERMAL NEUTRON REACTOR. Laponche, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1971. 139p. (In French). Dep. NTIS (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

In oscillation experiments, a standard fuel element of a critical experimental reactor is replaced by a sample of a material, the neutronic properties of which are to be found. An original method has been developed at the Commissariat à l'Energie Atomique and applied to fissionable materials: two signals resulting from the perturbation generated in the reactor are measured. One is the so-called "Global" signal, due to the change in reactivity (automatic driver position), the other is the "Local" signal, due to the change in the reaction rate of a detector located near the sample. Those independent signals give two relations between neutron absorption and production by the sample. Neutronic properties are deduced from the signals with the aid of a double calibration with samples of known laws of absorption and production. The equivalent sample technique is based on the definition of a fictitious sample, of known neutronic properties, with reaction rates of neutron absorption and production equal to those of the perturbing sample over a small area around the latter. Beyond this area only the intensity of the perturbation, and not its law vs. energy has an effect. It is then possible to reduce the amount of calculations, since an actual equivalence can be defined between any perturbing sample and calibration samples with known laws of perturbation. The method has been applied to the study of Pu–U alloys in graphite moderated lattices (CESAR and MARIUS reactors). Results are presented. 15 references. (auth)

34403 (JPRS-53069, pp 176-87) METHODOLOGICAL PROBLEMS OF TESTING FUEL ELEMENTS IN LOOP CHANNELS OF THE SM-2 AND MIR REACTORS. Tsykanov, V. A.; Aver'yanov, P. G.; Zverev, V. A.; Zaletnykh, B. A.; Klochkov, E. P.; Kormushkin, Yu. P.; Kuprienko, V. A.; Matveev, N. P. Translated from At. Energ. (USSR); 30: 192-8(1971).

The SM-2 reactor has two test loops and the MIR reactor has three loops. These facilities are used for testing fuels and structural materials in water or sodium environments. The principal design and operating characteristics of the loops are described. (H.D.R.)

34404 (WHAN-IR-30) INSTRUCTIONS FOR EVALUATION AND CONTROL OF FFTF DRIVER FUEL TEST EQUIPMENT. Stevenson, W. F. (WADCO Corp., Richland, Wash.). Nov 1970. 51p. Dep. NTIS.

The calibration and capabilities of each test equipment used in the acceptance testing of FFTF fuels and fuel components are described. (D.C.C.)

34405 LIDO HOT NEUTRON SOURCE EXPERIMENT. Carter, P. (Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Energy; 25: 11-26(Jan 1971).

Blocks of moderator at high temperature (Hot Sources) were installed in the beam tubes of reactors at Harwell for a number of years to provide beams of neutrons with enhanced intensity in the energy range 0.1–0.5 eV. Early designs were based on an empirical approach since no suitable calculation methods were available. Hence it was decided to carry out some basic experiments with various kinds and sizes of moderators at temperatures up to 1000°C, to provide data against which the various methods of calculation being developed could be tested. These experimental results are presented. Calculations of the rethermalization properties of the moderator blocks with a two dimensional transport code give satisfactory agreement with the experimental results. (auth) (UK)

34406 NEUTRON DOSIMETRY AROUND THE KOREAN TRIGA Mark-II REACTOR BY MEANS OF BONNER-SPHERE NEUTRON DETECTOR. Kim, Doo Hee; Ro, Seung Gy (Atomic Energy Research Inst., Seoul). New Phys. (S. Korea); 10: 149-56(Dec 1970).

Neutron dosimetry around the Korean TRIGA Mark-II reactor was performed using a Bonner-sphere neutron detector, a ^{6}LiI(Eu) scintillation crystal coupled with polyethylene spheres of various sizes. It appears that in the areas close to and in the direction of the beam ports a large fraction of the total neutron dose is composed of fast neutrons, while in other working areas the contribution by the intermediate-energy range neutrons from 0.12 eV to 1 MeV is considerably higher than those of either thermal or the fast neutrons. 26 references. (auth)

34407 TEST RESULTS AND THEIR ANALYSES ON PERFORMANCE OF JEFR SAFETY ROD DRIVE MECHANISM. Uga, Takeo (Japan Atomic Energy Research Inst., Tokai). Nippon Genshiryoku Gakkaishi; 13: 182-9(Apr 1971). (In Japanese).

Tests on the performance of the JEFR safety rod drive mechanism were conducted with water flow simulating the specified sodium environment. Results obtained during 400 cyclic endurance tests show that the scram period of the safety rod passing through the core from scram initiation to 600 mm displacement is 525 msec during the initial stages of test and 560 msec during final. To provide a means of predicting and analyzing the scram characteristics, a computer code was derived from the results of these tests. The code is described and an analysis performed on the scram characteristics of the safety rod drive mechanism and on the effects of acceleration spring and coolant flow rate on the scram period is presented. The main points are as follows: (1) The scram period is 6% shorter in sodium environment than in water due to the difference in density. (2) A spring force of 2 to 3 times the gravity of the safety rod is effective in shortening the scram period. (3) When the coolant velocity is designed to be much smaller than the mean velocity of the safety rod passing through the core, coolant flow rate would not influence the scram period to any extent. (auth)

34408 MEASUREMENT OF INFINITE MULTIPLICATION FACTOR IN HETEROGENEOUS U–H_2O SUBCRITICAL ASSEMBLY. Nakajima, Tadashi; Tojo, Takao; Kondo, Makoto (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 218-25(Apr 1971).

A method of determining k_∞ for subcritical heterogeneous assemblies with reflector is described. This method is based on the measurement of the equivalent infinite flux volume integral in an assembly containing no poison. To take account of the ex-

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perimental fact that radial flux distributions in the core are influenced by the heterogeneous core structure, the formulation for the integral was improved. On the basis of the equation thus formulated, the flux-distribution data were analyzed to yield a reliable value of the integral. The value of k_∞ is determined by combining this integral with the measured thermal utilization. The result obtained by this method is compared with that given by the buckling measurement using the critical equation. The two results are in good agreement. The present method is considered particularly useful for the determination of k_∞ in unpoisoned heterogeneous assemblies. 10 references. (auth)

34409 MEASUREMENT OF FAST NEUTRON SPECTRUM WITH ^{3}He PROPORTIONAL COUNTER. Iijima, Tsutomu; Mukaiyama, Takehiko; Shirakata, Keisho (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo); 8: 192-200(Apr 1971).

Experiments have been performed with the view to applying the ^{3}He proportional counter to differential measurements of the continuous neutron spectrum in a fast reactor. The results of measurements in the JAERI Fast Critical Facility (FCA) proved the apparatus to be useful for the measurements of the main part of the fast reactor spectrum. A specially devised electronic circuit was employed to eliminate the effect of differences in the rise-times of pulses; the energy resolution of the spectrometer was 25 keV (F.W.H.M.). The modified inverse matrix method was used to obtain the neutron spectrum from the measured pulse-height distribution, resulting in an improvement of the effective energy resolution in the resultant spectrum to about 10 keV. The applicable energy range of the spectrometer is for the time being from 20 keV to 2 MeV. 10 references. (auth)

34410 APPLICATION OF FISSION TRACK DETECTORS AS REACTOR NEUTRON TEMPERATURE MONITOR. Liu, T. C.; Su, C. S. (National Tsing Hau Univ., Hsinchu, Taiwan). Int. J. Appl. Radiat. Isotop.; 22: 227-32(Apr 1971).

Application of fission track detectors to measure the effective neutron temperature in a thermal reactor is proposed. This technique showed a number of advantages in comparison with ordinary methods. Glass slides were used as fission track detectors to register the total fission events of ^{239}Pu and ^{235}U irradiated simultaneously in the reactor. The effective neutron temperature can then be calculated from the ratio of fission tracks. Examples are given for the temperature measurements at the water region close to the reactor core and at the thermal column of the Open Pool reactor. Results show that the effective neutron temperatures differed more from the medium temperatures as the irradiation positions came closer to the reactor core. (auth) (UK)

34411 REACTOR ASSEMBLY: ARCHITECTURE, CIVIL WORKS, AND INSTALLATIONS. Moctezuma, P.; Fonseca, C.; Morales Amado, A.; Ley-Koo, Victor (CNEN, Mexico City). Rev. Mex. Fis., Supl. Reactor; 19: S9-25(1970). (In Spanish).

The reactor complex of the Nuclear Center of Mexico located at Salazar consists of five main buildings: the reactor building which houses the reactor room, control room, operator's office, machine room, visitor's gallery, activation analysis laboratory and counting room; the low radioactive level laboratory building with sections of nuclear chemistry, reactor physics and reactor engineering, gamma spectrometry, neutron spectrometry, isotope production, counting room, health physics, radioactive wastes and isotopes application to agriculture, the last one is located provisionally in this building; the high radioactive level laboratory building, for remote control handling of very high activities, with work shop to handle radioactive materials and equipment decontamination room; the common services building with sections of: personnel decontamination, laundry, change room, infirmary, mechanical and electronic work shop and warehouse for chemical materials and electronic components; the administrative building with offices for the director and for the researchers; library, cafeteria, classrooms and a meteorological station. These buildings have sanitary services, heating and electrical substation. The liquid radioactive waste piping is installed in underground galleries terminating at a waste yard where they are processed. The design of buildings and specification of materials have been made taking into account the relevant aspects of health physics, architectural functionality and future expansion. (auth)

34412 TRIGA MARK III OF THE NUCLEAR CENTER OF MEXICO. DESCRIPTION, CONSTRUCTION, INSTALLATION, AND OPERATION. Morales Amado, A.; Lopez Carrasco, F.; Ley-Koo, Victor; (and others) (CNEN, Mexico, City). Rev. Mex. Fis., Supl. Reactor; 19: S27-78(1970). (In Spanish).

The TRIGA MARK III reactor of the Nuclear Center of Mexico is a swimming pool type reactor, cooled, moderated and reflected with light water, which uses Zirconium hydride (ZrH) mixed with 20% ^{235}U enriched uranium as fuel-moderator. It is designed to operate at a steady state power of one megawatt or in pulsing at a maximum power of 1500 megawatts, being the pulse width of ten milliseconds. This reactor is utilized for basic and technological research, teaching and training, and isotope production. Since January 1969, the reactor has been operated by the reactor group with a schedule fixed by the demand, and has produced, during 1969, 179.44 MWH of energy. (auth)

34413 MEASUREMENT OF EFFECTIVE NEUTRON TEMPERATURE IN URANIUM–GRAPHITE REACTORS. Lomakin, S. S.; Mordovskaya, T. S.; Panfilov, G. G.; (and others). This paper was summarized in At. Energ. (USSR); 29: 36-7(Jul 1970) as paper No. 403/5549. (In Russian).

The effective neutron temperature has been measured by the integral method in the natural uranium–graphite F-1 research reactor and in the reactor of the First Atomic Power Station (Obninsk). The measurements were made with ceramic activation detectors made of lutetium and manganese in the form of disks 8 mm in diameter. The results were processed using the Westcott formalism modified for the case of detectors of finite thickness. The detectors were calibrated in a graphite pile with a thermalized neutron spectrum. Detector activity was measured with a γ-scintillation counter with a NaI(Tl) crystal and a PP-9 scaler equipped with an integral discriminator to preset the desired thresholds. The measured saturation activities of the detectors, the cadmium ratio, and the calibration utilization factor were used to calculate the neutron temperature. Measurements in the F-1 reactor were made at the core center. The neutron temperature T_n, averaged over four measurements using four different lutetium–manganese detector pairs, was 348 ± 10°K. At the First Atomic Power Station the measurements were made in an empty fuel channel; T_n was found as 393 ± 12°K. (auth)

34414 EVOLUTION: FTR FUEL PIN DESIGN TO PROCUREMENT. Burgess, C. A. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 2(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

34415 FTR DRIVER FUEL DEVELOPMENT PROGRAM STATUS. Roake, W. E. (WADCO Corp., Richland, Wash.). Trans. Amer. Nucl. Soc.; 14: Suppl. 1, 22(1971).

From Conference on fast reactor fuel element technology; New Orleans, La. (13 Apr 1971). See CONF-710414.

Rocket and Space Reactors

34416 (LA–4615) MEASURED ^{235}U AND ^{238}U FISSIONING NEUTRON FLUENCE DISTRIBUTIONS IN THE PHOEBUS 2A SHIELDS: COMPARISONS WITH MONTE CARLO CALCULATIONS. Watson, Clayton W. (Los Alamos Scientific Lab., N. Mex.). Nov 1970. Contract W-7405-eng-36. 33p. Dep. NTIS.

Fissioning-fluence distributions for ^{235}U and ^{238}U were measured in the facility and cart shields during the Phoebus 2A reactor tests. These data formed a diagnostic basis for upgrading both the neutron Monte Carlo codes and the Phoebus 2A reactor models being used for Rover neutron environmental calculations at Los Alamos Scientific Laboratory. Detailed comparisons with corresponding distributions calculated with both initial and improved codes and models are presented. Initial calculations gave results that were in poor to fair agreement with experiment, whereas the improved calculations were generally in good to excellent agreement. The changes required to achieve this agreement are discussed. Auxiliary studies and data, including calculated fission and absorption-rate distributions throughout a 5000-MW Phoebus 2A reactor-shield system, are presented in appendixes. 8 references. (auth)

34417 (Y-DA–3934) ANALYTICAL METHODS USED IN EVALUATING NERVA FUEL ELEMENTS. Clark, F. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 22 Feb 1971. Contract W-7405-eng-26. 13p. (CONF-710207–2). Dep. NTIS.

From twenty-second Pittsburgh conference on analytical chemistry and applied spectroscopy; Cleveland, Ohio (28 Feb 1971).

To prevent failure of a fuel element, which could result in an aborted flight, elaborate inspection procedures on both raw materials and fuel elements are required. Nondestructive measurement techniques such as DXT gauging, electrical resistance, gamma count, X-ray, beta backscatter, eddy current application for the location of matrix flaws, and gas leak rates are among those used in the evaluation of fuel elements. (J.M.J.)

34418 DISTRIBUTED PARAMETER TYPE OF CONTROL FOR A REACTOR OF NUCLEAR ROCKET. Liu, T. C.; Liu, B. L. (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 7: No. 3-4, 17-23(Oct 1970).

Attempts are made to control a reactor in both the time and space domains. A transformation method is introduced to transform a distributed parameter system into lumped parameter system so that the optimum theory can be applied. By the method of calculus of variations the control of a reactor is proved to be the bang-bang type. 17 references. (auth)

Process Heat and Desalination Reactors

Refer also to abstract 34388.

Marine and Portable Power Reactors

Refer also to abstracts 32755, 32758, and 32761.

34419 NAVAL NUCLEAR PROPULSION PROGRAM, 1971. HEARING BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-SECOND CONGRESS, FIRST SESSION, MARCH 10, 1971. TESTIMONY OF VICE ADMIRAL H. G. RICKOVER. Washington, D. C., Joint Committee on Atomic Energy, 1971. 303p. GPO $1.25.

The record of hearings held to obtain supplemental data for the fiscal year 1972 Atomic Energy Commission request for funds for the naval reactors development program is presented. The views of Admiral Rickover on the Soviet naval expansion and the U. S. naval strength are included. (H.D.R.)

Reactor Theory

34420 (BNWL-1559) ZODIAC-G: A CODE FOR MULTIGROUP, MULTIREGION BURNUP CALCULATIONS. Holeman, R. H.; Matsumoto, D. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1971. Contract AT(45-1)-1830. 108p. Dep. NTIS.

The ZODIAC-G computer code is designed to do one-dimensional, multigroup, multiregion burnup analysis of nuclear reactor fuel. The code is written for use on the UNIVAC 1108 computer. ZODIAC-G includes the reactor physics codes HRG, THERMOS, HFN, CLERKC, and ALCHEMY which are chained together for efficient use. ZODIAC-G is extremely flexible, thus it requires more input data than some other burnup codes. Microscopic cross sections can be recalculated whenever desired during a burnup calculation. Nonburnup problems can be run very easily by using component codes of ZODIAC-G. 9 references. (auth)

34421 (TID-25691) JOSHUA TERMINAL SYSTEM. Jensen, J. C.; Boyce, R. L.; Suich, J. E.; Haywood, R. C. (Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.). 18 Mar 1971. Contract AT(07-2)-1. 10p. Dep. NTIS.

The JOSHUA reactor physics computational system was designed to enable users to execute modules and to have access to an extensive data base with remote display terminals. The JOSHUA Terminal System (JTS) was developed to provide the terminal facilities required for module execution and data base manipulation. The capabilities of the JTS are described, its implementation is discussed, and some experience with the system is presented. (H.D.R.)

Kinetics

Refer also to abstracts 33373, 34328, and 34408.

34422 (EUR-4603) XBWR: A ONE DIMENSIONAL XENON TRANSIENT PROGRAMME FOR BOILING NUCLEAR REACTORS. Forti, G. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 14 Oct 1970. 46p. Dep. NTIS (U. S. Sales Only). EUR F.Fr. 7.75.

XBWR is a FORTRAN program for the analysis of xenon transients in axial geometry. It couples a two group neutron diffusion calculation in plane geometry with a two phase flow cooling channel calculation and the heat conduction in the typical fuel rod. The program allows to follow any given power time schedule, such as shut-down and restart, day-night power variation etc., while the reactor is being kept critical by control rod movement, variable poisoning of the core, or coolant flow recirculation rate. The xenon and iodine concentrations variations are evaluated pointwise (up to 100 points) by analytical solution for successive fixed time steps. At the end of each time step a new distribution of fluxes, power, voids and temperatures is obtained, which is consistent with the reactor critical condition as it is obtained by variation of the control parameter taking into account the feedbacks. The new flux distribution is used as input for xenon and iodine concentrations evolution in the next time step. (auth)

34423 (GULF-RT-10469) INTEGRAL NEUTRON THERMALIZATION. Final Report. Neill, J. M.; Borgonovi, G. M.; Houston, D. H.; Slaggie, E. L. (Gulf Radiation Technology, San Diego, Calif.). 30 Dec 1970. Contract AT(04-3)-167. 54p. Dep. NTIS.

The work performed on the Integral Neutron Thermalization Program from October 1, 1969 through September 30, 1970, is described. The development of scattering kernels to describe the thermalization of neutrons in important reactor moderators was the primary goal of the project. Concrete results of the program include thermal scattering kernels for Be, BeO, CH_2, C_6H_6, and ZrH_2 obtained from basic physics models. The main goal for the project in the final contract year was to check the consistency and accuracy of the thermal data as compiled in the ENDF and to insure that the system of data retrieval is convenient and suitably user-oriented. The FLANGE-II code is an essential link between data files and user applications, and considerable effort was made to improve the versatility of this code. The work done on FLANGE is summarized. Checks made directly on the scattering law data in the ENDF are viewed. Comparisons between measured and calculated neutron spectra that have been added to the SPECTRUM BOOK are discussed. The conversion of the McMurry-Russell-H_2O data to ENDF/B format is described and some difficulties encountered in the use of this model are related. The work on the series of thermal benchmark problems which have served as a test of the Haywood II water scattering kernel and of Version I and II ENDF cross sections for isotopes of uranium and plutonium is summarized. Final documentation for descriptions of the scattering kernels and further references contained in the KERNEL BOOK are presented. 33 references. (H.D.R.)

34424 (IA-1217) SHOVAV: PROGRAM TO SOLVE THE FEW-GROUP SPACE-TIME DEPENDENT DIFFUSION EQUATION WITH TEMPERATURE FEEDBACK. Saphier, D.; Yiftah, S. (Israel Atomic Energy Commission, Tel Aviv). Jan 1971. 134p. Dep. NTIS (U. S. Sales Only).

A computer program SHOVAV for solving the space-time dependent diffusion equation with temperature feedback is described. The diffusion equation is solved for a slab reactor with a maximum of eleven regions, one hundred mesh points, four energy groups and six delayed neutron groups. Ten isotopes may be present in the mixture. The mean fuel and coolant temperatures at each mesh point are calculated and their influence on the coolant density and the various cross sections is taken into account via the cross section mixing and shielding factors. (23 references) (auth)

34425 (IA-1232) ESTIMATE OF THE ERROR BETWEEN B_{N+1} AND B_N APPROXIMATIONS. Ronen, Y. (Israel Atomic Energy Commission, Tel Aviv). Dec 1970. 12p. Dep. NTIS (U. S. Sales Only).

The functional analysis method for error estimate is applied to estimate the error between the B_{N+1} and B_N approximations. The bound obtained is compared with the actual error for the case of B_1 and B_0 approximations. (3 references) (auth)

34426 (LA-4616) ANCON USER'S MANUAL. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). May 1971. Contract W-7405-eng-36. 41p. Dep. NTIS.

The ANCON code is a FORTRAN-IV program that solves the point reactor kinetic equations, including thermal feedback. Lump-type heat balance equations are used to represent the thermodynamics, and the heat capacity of each lump can vary with temperature. Thermal feedback can be either a linear or a nonlinear function of lump temperature, and the impressed reactivity can be either a polynomial or sinusoidal function. A description of the equations solved by the code, a description of the computational algorithms, detailed input specifications, and other information required for effective use of the code are presented. The code is structured in a form such that reactivity or heat balance options, other than those presently available, can be incorporated with a minimum of code modification. (auth)

34427 (ORNL-TM-3200) APPLICATION OF VARIATIONAL SYNTHESIS TO SOLUTIONS OF MULTIDIMENSIONAL NEUTRON

XUM

TRANSPORT PROBLEMS. Cobb, William Ronald (Oak Ridge National Lab., Tenn.). Apr 1971. Contract W-7405-eng-26. 156p. Dep. NTIS.

Thesis. Submitted to Georgia Inst. of Tech., Atlanta.

The variational synthesis method has been applied to the steady-state Boltzmann neutron transport equation in two- and three-dimensional rectangular geometry. In this application the energy dependence has been treated in the standard multigroup energy approximation, the dependence along all but a single remaining spatial variable has been treated by a multichannel discontinuous spatial synthesis approximation and the angular dependence has been treated by a discrete ordinate approximation. All approximate treatments of these variables have been developed consistently from a variational principle by the standard trial function reduction procedure, applied sequentially to the energy variable, the spatial variables and the angular variable. The approximate method as developed in this application allows the user to obtain approximate solutions to the transport equation by combination of the solutions to related problems of lower dimensionality. An experimental computer code has been written for use in obtaining approximate solution to the two-dimensional, one energy group problem with isotropic scattering. The experimental computer code has been used to obtain approximate solutions to several test problems of the type encountered in the reactor field and the accuracy and comparative cost of these approximate solutions has been determined by comparison to consistently obtained direct solutions to the same problems. Both fixed source and eigenvalue problems, as well as problems with both vacuum and reflected boundary conditions, have been investigated. Results of the test problems have indicated that the method, as developed, is capable of producing accurate approximate transport solutions at a fraction of the cost of the direct solutions, and with accuracy superior to the diffusion approximation. (51 references) (auth)

34428 APPLICATION OF THE j_N METHOD TO NEUTRON TRANSPORT IN A COUPLED CORE ASSEMBLY. Mangiarotti, L. (Univ., Florence). J. Nucl. Energy; 25: 35-40(Jan 1971).

The neutron transport phenomenon in a system composed of two multiplying cores separated by an absorbing region is studied. A set of coupling terms is introduced between the two cores and numerical examples in the first (j_0) approximation are given. (auth) (UK)

34429 MEASUREMENT OF MATERIAL BUCKLING AS A FUNCTION OF VOID FRACTION IN A SUB-CRITICAL ASSEMBLY. Twum-Danso, L.; Cooper, P. N. (Univ. of Aston, Birmingham, Eng.). J. Nucl. Energy; 24: 587-91(Jan 1971).

Voids were introduced into a natural uranium water moderated sub-critical assembly by passing compressed air through the moderator. Changes in material buckling were measured using foil activation techniques over a range of void fractions from 0 to 9%. Calculations showed that three group diffusion theory can adequately represent the lattice characteristics provided care is taken in calculation of resonance capture in ^{238}U and in calculation of fine structure. The presence of voids can be simply regarded as a decrease in moderator density. (auth) (UK)

34430 P_∞ SOLUTION FOR NEUTRON TRANSPORT IN HETEROGENEOUS MEDIUM BY SEMIGRAPHICAL METHOD. Cheng, Chen-hwa; Lin, Shuang-chi (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 7: No. 3-4, 24-31(Oct 1970).

A method by graphical extrapolation by using P_1 up to P_5 solutions to arrive at a value for P_∞ is shown. Its dependability and simplicity are discussed. 4 references. (auth)

34431 APPLICATION OF FAST FOURIER TRANSFORM ALGORITHM TO ON-LINE DIGITAL REACTOR NOISE ANALYSIS. Izumi, Masayuki (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: 236-39(Apr 1971).

The fast Fourier transform algorithm is described and is applied to the calculation of the power spectral density as a function of neutron flux and coolant flow rate in the Hitachi Training Reactor. (H.D.R.)

34432 MAXIMIZATION OF THE MEAN IN-PILE BURN-UP IN A NATURAL URANIUM REACTOR WITH A TWO-DIRECTIONAL AXIAL FUEL SHUFFLING. Bartosek, Vaclav (Inst. for Nuclear Research, Rez, Czech.). Ind. At.; 14: No. 11-12, 23-7(1970). (In French).

A rigorous formulation of the problem for a given reactor with a given reflector thickness is presented. An analytic solution is given for the maximization of the burnup distribution for a homogeneous slab model in the one group theory using the Pontryagin maximum principle. The gain in mean burnup in relation to a constant burnup distribution is a few percent. (auth) (France)

34433 DESTABILIZING EFFECT OF A PROMPT POSITIVE COOLANT COEFFICIENT. Smets, Henri B. (Univ., Liege). Energ. Nucl. (Milan); 18: No. 4, 217-20(Apr 1971).

It is proved that finite escape time solutions of the reactor kinetic equations always exist whenever the Laplace transform of the reactivity kernel is given by a rational function satisfying particular conditions. It is shown analytically that the phase space contains an infinite number of trajectories which reach asymptotically the finite escape time solution, and a method is given for the determination of the instability region. (auth)

Dynamics

34434 ERROR ANALYSIS OF THE PROMPT-JUMP APPROXIMATION. Amano, Fumio (Electrotechnical Lab., Tokyo). J. Nucl. Sci. Technol. (Tokyo); 8: 184-91(Apr 1971).

A detailed error analysis of the prompt-jump approximation (PJA) is described. Improvements on the accuracy of the PJA by application of the singular perturbation method are discussed. The correction factor derived for interpreting the validity of the PJA is effective in estimating numerical errors based on the PJA and calculating its first-order correction. Taking three representative cases (step, ramp and periodic inputs), the numerical errors qualitatively and quantitatively are examined through comparisons with exact solutions obtained by the Runge–Kutta–Merson method. As a result, it is confirmed that solutions based on the PJA would generally result in overestimation in the case of step and ramp inputs, and that the accuracy of the PJA is considerably improved by correction. 7 references. (auth)

Experimental Applications

34435 EXPERIMENTAL STUDIES OF UO_2–H_2O UNIFORM LATTICES. Wajima, J. Tsunetaka; Yamamoto, Hisashi; Kikuchi, Hiroshi; (and others) (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 8: 201-17(Apr 1971).

An experimental technique to evaluate models for lattice calculation by measuring microparameters is presented. It is shown that a generalized four-factor formula expressed in terms of the microparameters could successfully evaluate sources of discrepancy between measurement and calculation in regard to gross quantities, such as critical mass and multiplication factor. Lattices studied are of UO_2, enriched in ^{235}U to 2.5 and 1.5 wt%, with water-to-fuel volume ratio ranging from 0.43 to 3.5. Detailed description is given on the measurement of the microparameters in epithermal and fast energy regions. Analysis of the results has been made mostly with the JUPITER (modified MUFT)–THERMOS–SUNRISE (diffusion) code system. A new experimental approach for directly measuring the non-leakage probability is also presented. The multiplication factor obtained by this method is compared with that derived from the microparameters. The resulting good consistency supports the validity of both of these experimental techniques. 24 references. (auth)

34436 MEASUREMENT OF NEUTRON IMPORTANCE FUNCTIONS. Greenspan, Ehud (Nuclear Research Center-Negev, Beer-Sheva, Israel); Cady, K. B. J. Nucl. Energy; 24: No. 11, 529-50(Dec 1970).

The theory and measurement of neutron importance functions are discussed by formulating a classification scheme for the different ways of measuring importance function distributions. The scheme is based on the statement of the theoretical interpretation of the experiment; that is on the exact equations which govern the measurements. The classification scheme consists of six methods utilizing neutron sources and one method utilizing small sample perturbations. Procedures for obtaining from these measurements the value of certain reactor parameters, including the geometric buckling, β/Λ, and reactivity, are also outlined. The source multiplication method using a ^{252}Cf spontaneous fission source and the perturbation method using boron and cadmium samples are illustrated by comparing experimental data and calculated results for a reflected light water reactor. Four-group diffusion-theory calculations are in good agreement with the measurements. A value of 29.00 ± 0.05 cm is obtained for the extrapolated reactor radius from the ^{252}Cf radial traverse as compared with 28.94 ± 0.08 cm and 29.90 ± 0.66 cm that had been measured respectively from Mn and ^{232}Th foil activation. (auth) (UK)

34437 SPATIAL DISTRIBUTION OF MODERATED NEUTRONS IN HYDROGENEOUS MEDIA. Lin, Chia-shi; Tsai, Jensan (National Tsing Hua Univ., Hsinchu, Taiwan). Nucl. Sci. J. (Taiwan); 7: No. 3-4, 1-7(Oct 1970).

Uranium and aluminum samples are exposed to an unfiltered or filtered narrow neutron beam from the reactor and only the fast component of the resulting neutrons is allowed to go through hy-

drogeneous media for slowing down and is eventually detected by a ^{10}B coated proportional counter. The spatial distribution of slowing down neutrons is studied for different slowing down kernels and the results compared. It is interesting to note that in the case of assuming the convolution of the three group diffusion kernels only one set of parameters fits well the two cases of primary beam unfiltered and filtered whereas two sets of parameters are needed if other kernels are assumed. (auth)

34438 EVALUATION MODEL OF ABSORBING ROD REACTIVITY WORTH AND COMPARISON WITH EXPERIMENTS FOR B_4C ABSORBERS. Claps, M.; Rama, P. G. (FIAT, Turin). Energ. Nucl. (Milan); 18: No. 4, 211-16(Apr 1971).

A method is described to evaluate the reactivity worth of clustered or uniformly distributed cylindrical absorbers. Computational methods normally used in reactor design are involved, and an accuracy better than 5% in absorber worth is obtained for B_4C absorbers by comparison with critical experiments performed on slightly enriched, water moderated, UO_2 lattices. The method can be applied with proper modifications to other absorbing materials. 9 references. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 32102, 32112, 32124, 32643, 32668, 32685, 32686, 32751, 32760, 32776, 32818, 32823, 32843, and 32844.

34439 (JPRS-53069, pp 256-62) MECHANISM OF RADIATION DAMAGE AND OPERATING LIFE OF STRUCTURAL GRAPHITES AT HIGH TEMPERATURES AND NEUTRON FLUXES. Klimenkov, V. I.; Zolotukhin, V. R. Translated from At. Energ. (USSR); 30: 231-4(1971).

The effects of neutrons on graphite structures at various temperatures are analyzed from the standpoint of crystal defect production and interaction. In particular, the mechanism of radiation effects on swelling of graphite is examined. (15 references) (H.D.R.)

34440 IMPROVEMENTS IN OR RELATING TO FUELS FOR NUCLEAR REACTORS. (to Le Carbone-Lorraine). British Patent 1,230,549. 5 May 1971. Priority date 4 Feb 1969, France.

REACTOR FUELS—fabrication of graphite matrix pyrolytic carbon coated particle type (D.C.C.)

XUM

GENERAL

34441 (AECL–3729) ANALYSIS OF TRANSMISSION ELECTRON DIFFRACTION PATTERNS BY COMPUTER. Ploc, R. A.; Keech, G. H. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Jan 1971. 42p. Dep. NTIS (U. S. Sales Only). AECL $1.50.

34442 (BDX–613–315) FAST RECOVERY TIME DIODE TESTING. Final Report. Flowers, R. R. (Bendix Corp., Kansas City, Mo.). Mar 1971. Contract AT(29-1)-613. 47p. Dep. NTIS.

34443 (BDX–613–321) ALUMINUM PULSE-ARC WELDING. Final Report. Hollar, D. L. (Bendix Corp., Kansas City, Mo.). Mar 1971. Contract AT(29-1)-613. 21p. Dep. NTIS.

34444 (BNL–50262) BROOKNET: BROOKHAVEN ONLINE REMOTE NETWORK. Friedman, Jerry; Padwa, Larry (Brookhaven National Lab., Upton, N. Y.). Dec 1970. 33p. Dep. NTIS.

34445 (CEA-R–4151) APPARATUS FOR MEASURING FLUORESCENCE TIMES, IN THE NANOSECOND REGION, FOR CERTAIN ORGANIC MOLECULES. Breuze, Gerard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1971. 46p. (In French). Dep. NTIS (U. S. Sales Only).

34446 (COO–2034-4) ELASTIC FIELDS OF INCLUSIONS IN ANISOTROPIC MEDIA. Kinoshita, N.; Mura, T. (Northwestern Univ., Evanston, Ill.). [1970]. 19p. Dep. NTIS.

34447 (COO–2034-5) GREEN'S FUNCTIONS FOR ANISOTROPIC ELASTICITY. Kinoshita, N.; Mura, T. (Northwestern Univ., Evanston, Ill.). [nd]. 22p. Dep. NTIS.

34448 (COO–2034-6) DISLOCATION STRESSES IN A THIN FILM DUE TO THE PERIODIC DISTRIBUTIONS OF DISLOCATIONS. Saito, K.; Bozkurt, R. O.; Mura, T. (Northwestern Univ., Evanston. Dept. of Civil Engineering). [1970]. 23p. Dep. NTIS.

34449 (COO–2040-4) CONTINUED PROLIFERATION OF MITOGEN-STIMULATED HUMAN PERIPHERAL BLOOD LYMPHOCYTES. Progress Report 1970–71. Munakata, Nobuo; Strauss, B. (Chicago Univ., Ill. Dept. of Microbiology). Contract AT(11-1)-2040. 26p. Dep. NTIS.

34450 (COO–2094-5) LIST-STRUCTURED ADDRESSING. Fabry, Robert S. (Chicago Univ., Ill. Inst. for Computer Research). Mar 1971. Contracts AT(11-1)-614; AT(11-1)-2094. 163p. Dep. NTIS.
Thesis.

34451 (COO–2118-6) ILLIAC III REFERENCE MANUAL. VOLUME II. INSTRUCTION REPERTOIRE. Report No. 434. McCormick, B. H.; Nordmann, B. J. Jr. (eds.) (Illinois Univ., Urbana. Dept. of Computer Science). 26 Feb 1971. Contracts AT(11-1)-1018; AT(11-1)-2118. 182p. Dep. NTIS.

34452 (KFK–1327) NEUTRON SCATTERING FROM SOLID HYDROGEN. Schott, W.; Rietschel, H. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Kernphysik). Nov 1970. 27p. Dep. NTIS (U. S. Sales Only).

34453 (LA–4426) FLASH X-RAY OBSERVATION OF THE FLOW BEHIND A DETONATION WAVE. Rivard, W. C.; Venable, Douglas (Los Alamos Scientific Lab., N. Mex.). Jun 1970. Contract W-7405-eng-36. 40p. Dep. NTIS.

34454 (LA–4603) MONTE CARLO TRAJECTORIES: THE DYNAMICS OF THE REACTION $F + H_2$. Blais, N. C. (Los Alamos Scientific Lab., N. Mex.). Jan 1971. Contract W-7405-eng-36. 9p. Dep. NTIS.

34455 (LA-tr–71-31) CHOICE OF CONDENSER IN STUDY OF COMBINATION LIGHT SCATTERING. Rautian, S. G. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Zh. Eksp. Teor. Fiz.; 27: 625-35(1954). 17p. Dep. NTIS.

34456 (NP–18834) THEORY OF LINEAR SEQUENTIAL CIRCUITS OVER RINGS. Matluk, Mario Magidin (California Univ., Berkeley). Jun 1970. 85p.
Thesis.

34457 (NYO–2150-72) LOW TEMPERATURE ELECTROMAGNETIC GENERATION OF ULTRASOUND IN POTASSIUM. Wallace, W. D.; Gaerttner, M. R.; Maxfield, B. W. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Apr 1971. 13p. Dep. NTIS.

34458 (NYO–3504-53) FORMATION AND MIGRATION OF ARTIFACT VACANCIES INDUCED ON GOLD SURFACES BY NEON FIELD ION MICROSCOPY. Schmid, T. E.; Balluffi, R. W. (Cornell Univ., Ithaca, N. Y.). May 1971. 18p. Dep. NTIS.

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Germanic	ä	appears as ae
Germanic	ö	oe
Germanic	ü	ue
Scandinavian	ø	oe

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SUBJECT INDEX

Cross references are included in cumulative subject indexes and in *Subject Headings Used by the USAEC Division of Technical Information* (USAEC report TID-5001).

The reader is also referred to *Guide to Abstracting and Indexing for Nuclear Science Abstracts* (USAEC report TID-4576).

Most headings in the subject index are specific materials, things, and processes. The headings are followed by modifiers that describe the properties of, or processes applied to, the headings.

All index entries cite *NSA* volume and abstract numbers; volume number precedes the colon and the abstract number follows it. The designation (R) following the abstract number indicates a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Report numbers, where applicable, are included in parentheses after the abstract number of the citation. Published literature (journal article or book) can be identified by the absence of a report number.

Ideas presented in the original literature, rather than key words, have been indexed. The indexers have selected what seemed the most probable and logical place to look for typical information. Since it is not always possible to anticipate where a user would look for information, the cumulative indexes include numerous cross references. Consideration of synonymous or closely related terms will prove valuable.

Information is indexed for the greatest use to the greatest number of users. This requires that a topic be indexed to headings that most specifically describe it and not ordinarily to the headings that describe its ultimate use or to the general class headings that include the specific headings. For example, information on boiler design for the Fermi Fast Breeder Reactor would be indexed under the headings BOILERS and FERMI FAST BREEDER REACTOR but not necessarily under the headings REACTORS, FAST or REACTORS, BREEDER.

General or broad headings are reserved for general summaries, reviews, comprehensive reports, and similar literature.

Subject Heading Styles

Generally, the direct form of subject entry is used rather than inverted headings; e.g., AMINO ACIDS rather than ACIDS, AMINO; HELIUM ISOTOPES He-4 rather than HELIUM—ISOTOPES He-4 or HELIUM—He-4 ISOTOPES. Note, however, that in some cases parenthetic modifying terms or inverted headings such as NEUTRONS, FAST, are used where the alphabetical arrangement of a direct entry would cause information to be scattered. In addition, organic compounds are usually entered in the index in the inverted form to facilitate grouping like or related compounds with the parent compounds; e.g., BENZENE, BROMO- rather than BROMOBENZENE. In general, the nomenclature used is that of the subject indexes to *Chemical Abstracts*.

Alphabetization

Subject headings are alphabetized word by word. Parenthetic qualifiers, numbers, and Greek letters within subject headings are disregarded in alphabetizing unless there are two or more headings that are otherwise identical, in which case the qualifier, numerical progression, or spelled names for the Greek letters determine the order.

Examples:

M-Capture
  see ELECTRON CAPTURE
MAGNESIUM
MAGNESIUM ALLOYS AND SYSTEMS
MANGANESE FLUORIDES
MANGANESE FLUORIDES MnF_2
MESONS
MESONS (π)
MESONS (ρ)
1-PENTANOL
2-PENTANOL

Modifying Phrases

The modifiers appearing under a subject heading are written specifically to show the relation between the item being indexed and the heading. The modifier therefore contains a maximum of useful information. Although the modifier begins with the word judged to be of greatest use to the greatest number of users, there is still need for the searcher to consider all modifiers under the heading(s) of interest.

Modifiers usually form meaningful phrases when combined with the subject heading. Some are intended to be read following the subject heading, e.g., the entry HYDROGEN—sorption by charcoal should be read "hydrogen sorption by charcoal." As a result of placing the important word first, however, many modifiers must be rearranged for smooth reading, e.g., FORMALDEHYDE—yields in radiolysis of ethyl ether, effects of deuterium on, should be read "effects of deuterium on formaldehyde yields in radiolysis of ethyl ether" and URANIUM—crystal structure of, effect of cooling rate on allotropic transformations in, should be read "effect of cooling rate on allotropic transformations in crystal structure of uranium."

Special characters are added to modifiers in the fields of physics and reactor technology; if the modifier does not establish the experimental or theoretical character of a reference, a symbol (E), (T), or (E/T) is placed immediately after the modifying phrase and before the abstract number.

XUM

Physical States and Configurations of Materials

The specific physical state, if other than normal, or the geometric configuration of the material is included in the modifying phrase; e.g., information on liquid metals is indexed under the specific metal with "liquid" in the modifier and carbon crucibles is indexed under CARBON with "crucibles" appropriately placed in the modifier. The information on carbon crucibles is also indexed under CRUCIBLES.

Nomenclature of Inorganic Compounds

Inorganic compounds are indexed to subject headings in the direct form. Cations are listed in the order of increasing valence for polycationic salts of varying valence and in alphabetic order for polycationic salts in which all cations have the same valence; e.g., SODIUM ALUMINUM SILICATES and POTASSIUM SODIUM SULFATES. If more than one anionic species is presented in a compound, the anions are arranged alphabetically, e.g., BERYLLIUM FLUORIDE HYDROXIDES.

Nomenclature of Organic Compounds

Organic compounds are indexed by subject headings based on the indexes to *Chemical Abstracts* except in the area of enzymes, in which specific enzymes, named according to the 1964 recommendations of the International Union of Biochemistry, are used. In many cases nonproprietary names for drugs are used as subject headings, and cross references are made from the systematic chemical names. Subject headings for hormones appear in the inverted style at HORMONES.

Nomenclature of Life Sciences

Subject headings for plants are names of phyla with one exception: members of the Phylum Tracheophyta are indexed under class or subclass names. Scientific names (genus and species) are used as the initial, or file, word in the modifying phrase. Scientific names are omitted only when the name is not available in the literature or cannot be found in available references.

Subject headings for animals are the names of phyla with the following exceptions: (1) members of Phylum Arthropoda and Phylum Chordata are indexed under appropriate class name, and (2) common names are used for members of Class Mammalia.

Subject headings are entered for various classes of commodities, and specific products are identified in the file-word position of the modifier. In the following examples, approved subject headings are capitalized and typical modifier file words are listed in lower case.

Example 1	Example 2
CEREALS	MEATS
bread	beef
flour	fish
oats	mutton
rice	pork
rye	poultry
wheat	seafood

Diseases, pathological conditions, and in vitro studies of atypical cells and tissues are indexed under subject headings for the organism affected, under the appropriate anatomical structure of physiological phenomenon affected, and under the appropriate disease heading. Subject headings for diseases (defined as any deviation from the norm) are DISEASES; DISEASES, INFECTIOUS; DISEASES, NEOPLASTIC; DISEASES, PHYSIOLOGICAL; DISEASES, PLANT; and DISEASES, TRAUMATIC.

Diseases of mixed etiology are treated in the following manner: neoplastic diseases that are also classified as infectious or physiological are indexed under DISEASES, NEOPLASTIC; diseases in which a microorganism is the etiologic agent are classified under DISEASES, INFECTIOUS; physiological anomalies that are neither neoplastic nor infectious are indexed under DISEASES, PHYSIOLOGICAL; the acute radiation syndrome, nonspecific radiation injuries, trauma, and wounds or incisions inflicted mechanically are indexed under DISEASES, TRAUMATIC.

Specific diseases or pathological conditions are named in the file-word position of the modifier, in the author's terminology, and are set off from the remainder of the modifier by commas. Neoplasms are designated as benign or malignant in the file-word position when more specific information is not available.

Multicomponent Alloys and Other Systems

Multicomponent alloys and systems, except well-known trade names, are indexed under a subject heading for each component in the form "element systems" for nonmetals or "element alloys and systems" for metals. The modifier begins with element symbols for each component arranged alphabetically. In addition, if significance is placed on the base metal of the alloy, this is indicated by adding "-base" to the element symbol.

Example: A 1.5C, 12Cr, 0.25V, 0.8Mo, bal Fe alloy is indexed as

```
CARBON SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
CHROMIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V,...
IRON ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
MOLYBDENUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
VANADIUM ALLOYS AND SYSTEMS
  C--Cr--Fe-base--Mo--V, ...
```

Well-known alloys, such as ZIRCALOY-2, are indexed under the trade name; cross references from each component of the alloy to the trade name appear in cumulative indexes.

Multicomponent systems in which nonmetallic elements are present in large percentage and which are commonly referred to as systems or mixtures are indexed in a manner similar to alloys.

Example: A tungsten–silicon preparation is indexed as

```
TUNGSTEN ALLOYS AND SYSTEMS
  Si--W, ...
SILICON SYSTEMS
  Si--W, ...
```

Multicompound systems and mixtures of inorganic compounds are indexed under the subject heading for each component compound; the modifiers begin with an alphabetical listing of compound formulas.

Example: A lead titanate–lead zirconate mixture is indexed as

```
LEAD TITANATES
  PbTiO3--PbZrO3
LEAD ZIRCONATES
  PbTiO3--PbZrO3
```

A mixed system of compounds and elements is indexed by a combined form of the preceding conventions; e.g., a dispersion of copper and alumina would be indexed as

ALUMINUM OXIDES
  Al_2O_3--Cu, ...
COPPER ALLOYS AND SYSTEMS
  Al_2O_3--Cu, ...

Mixtures of organic compounds are indexed under subject headings for each component of the mixture; the modifiers begin with an alphabetical listing of compound names.

Example:

ACETIC ACID
  acetic acid--BF_3, ...
BORON FLUORIDES
  acetic acid--BF_3, ...

Example:

BENZENE, CHLORO-
  bromophenol--chlorobenzene, ...
PHENOL, BROMO-
  bromophenol--chlorobenzene, ...

If modifiers for alloys and systems are included with other modifiers under the same subject heading, they are filed last.

Example:

CARBON SYSTEMS
  deposition on nuclear fuel particles
  molecular structure of
  neutron total cross section for
  sorptive properties for xenon
  Young's modulus for
  Al--C--Cr, superconductivity in
  B--C, phase studies for
  C--U--Zr, fabrication and physical properties of

Nomenclature of High Energy Physics

Information on particle-particle events is indexed under subject headings for the specific particles involved. The modifier file word *interactions* is followed by the specific interaction written in symbolic form. Particle nomenclature and symbols follow that of Rosenfeld, et al. *Data on Particles and Resonant States,* UCRL-8030 (latest revision). For consistency the incident particle is always written first. The mass (in MeV) of a resonance state is included in parentheses after the symbol to avoid ambiguity. Hyperfragments are indicated in modifiers as in the following examples: Λ-He^5, Σ-H^3, $\Lambda\Lambda$-Be^{10}. The superscript on the right indicates the total number of baryons in the composite system.

Examples:

MESONS (π^-)
  interactions $\pi^- + p \rightarrow \Lambda + K^+ + \pi^-$ at 6 GeV/c in hydrogen bubble chamber, ΛK(1700) enhancement in, (E)
BARYONS, RESONANCE (N*)
  production of $\Delta^{++}(1236)$ and $\Delta^0(1236)$ from $K^- + p \rightarrow K^- + p + \pi^+ + \pi^-$ interactions at 2.63 and 2.70 GeV/c, (E)
HYPERFRAGMENTS
  binding energy of $\Lambda\Lambda$-He^6, three-body α--Λ--Λ model for

Subject headings are also provided for specific models and theories.

Examples:

ELEMENTARY PARTICLE MODELS (TRIPLET)
  hadron total cross sections in quark, numerical analysis of
CURRENT ALGEBRA
  PCAC hypothesis for A_1 and rho dominance in $\pi \rightarrow e + \nu + \gamma$ decay
REGGE POLE THEORY
  predictions for polarization in $K^- + p \rightarrow$ anti $K^0 + n$, $\pi^- + p \rightarrow \pi^0 + n$, and $\pi^- + p \rightarrow$ eta + n interactions at high energies
SYMMETRY GROUPS
  SU(2) × SU(4) intermediate-coupling model for nucleon and hyperon isobars

Nomenclature of Reactor Technology

Subject headings for reactors are of three types:

(1) Specific reactors, e.g., ARGONNE RESEARCH REACTOR, SAXTON POWER REACTOR

(2) Reactors having a common physics or engineering characteristic, e.g., REACTORS, FAST; REACTORS, ORGANIC-COOLED; REACTORS, PRESSURIZED-WATER

(3) Reactors having a common purpose, e.g., REACTORS, POWER; REACTORS, RESEARCH

Information on specific reactors, type (1), is indexed under the one specific subject heading. Information on classes or types of reactors, types (2) (characteristics) and (3) (purpose), is indexed under all applicable headings. For example, information on a heavy-water-moderated organic-cooled power reactor is indexed under REACTORS, HEAVY WATER-MODERATED; REACTORS, ORGANIC-COOLED; and REACTORS, POWER.

Subject headings exist for selected reactor components, e.g., REACTOR FUEL ELEMENTS. When applicable, headings for components are indexed even though they may have been included in a modifier under a type (1) or (2) heading. The materials in reactor components are indexed when the information is peculiar to the material.

Modifier file words under reactor headings are of two primary types: one type expresses reactor characteristics, e.g., reactivity; the other, components, e.g., control rod. If no subject heading appears for a reactor component, the heading REACTORS is used, and the component is used as the modifier file word.

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